RUGGEDISED
Designing smart, resilient cities for all

EUROPEAN COMMISSION
Horizon 2020
H2020-SCC-2016
GA No. 731198

Deliverable No.	RUGGEDISED D1.1	
Deliverable Title	Lessons learned on the implementation of smart solutions in the Lighthouses 1/3	
Dissemination level	Public (PU)	
Lead participant	TNO	
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Status	**Final**	28-2-2018

H2020-SCC-2016 – Grant Agreement number 731198 - RUGGEDISED

Acknowledgement:

The author(s) would like to thank the partners in the project for their valuable comments on previous drafts and for performing the review.

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Disclaimer:
This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 731198. The sole responsibility for the content of this document lies with the Ruggedised project and does not necessarily reflect the opinion of the European Union.

Executive summary

The Liaison Groups provide lighthouse cities with a seamless knowledge brokerage service to transfer and translate state-of-the-art knowledge into practice. To ensure that the local consortium partners in the lighthouse cities do not work in isolation, the groups are meant to engage peers in the other lighthouse cities, including those working in the follower cities. This peer to peer learning enriches the design of smart solutions and improves their implementation processes. Furthermore, the lessons taken from the cross-city learning will also facilitate replication and upscaling of the solutions in the follower cities (Brno, Gdansk and Parma) and other EU-cities. From each lighthouse city (and local consortium) participants exchange their challenges and experiences and by doing so learn from each other. At the same time, they help each other to analyse the key elements that facilitate or hinder implementation and to jointly articulate additional knowledge questions. The function of the Liaison Groups in that sense is not only on a practical level, but also on a more fundamental level of collaboratively building capacity to deal with complexity and urban innovation processes.

This deliverable 1.1 is the first out of three reports discussing the 'lessons learned' from the Liaison Groups. Since it is the first report, it reflects on the functioning of the cross-city learning process in the Liaison Groups, rather than on the smart solution implementation processes itself. The deliverable includes the minutes of the Liaison Group meetings in the Appendix. The main body of the deliverable provides a reflection on and synthesis of the outcomes and functioning of the Liaison Groups.

In general the Liaison Groups made a good start, especially because cross-city learning is of interest to everyone. On the other hand, it develops slowly, as it takes time to get to know each other and appreciate each other's backgrounds.

The aim for the upcoming period is to proceed with the way in which the Liaison Groups currently run. Exchanging lessons learned will stay important, but the focus will slightly shift towards capacity building and collaborative knowledge development. Together with the participants we want to improve the capacity to deal with complex (socio-technical) systems and their challenges, especially regarding understanding the diversity of the system, opening up windows of opportunity, identifying knowledge gaps and filling these with collaboratively developed knowledge.

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1. Introduction

In Work Package 1 of the RUGGEDISED project, the main task is to “prepare the ground for innovation and implementation of measures in the lighthouse cities”. Following this aim, WP 1 develops a process to facilitate the lighthouse cities’ implementation of the smart solutions. This process is based on learning across the cities by exchanging experiences, discussing challenges and articulating the need for support from their knowledge partners (TNO for Rotterdam, SP for Umea, and University of Strathclyde for Glasgow). Cross-city learning takes place in Liaison Groups. In the beginning of the project three thematic Liaison Groups were formed; on hardware, software and orgware aspects of the implementation of smart solutions. In each group at least one person from each lighthouse city participates. Moreover, the knowledge partners (TNO, SP and University of Strathclyde, AIT) are also part of the Liaison Groups. The local implementation partners are also welcome to join the discussions. The lighthouse cities take the lead in inviting them to the discussions. This is to ensure that the cities themselves orchestrate the process. The Liaison Groups meet twice a year during the implementation phase of the smart solutions, i.e. the first three years of the project. Sometimes the three groups meet all together and sometimes only the specialists of one of the tracks meet. After the three year period the lessons learned and experiences will be condensed in guidance in easy to read documents (Deliverables 1.6, 1.7, 1.8).

1.1 The aim of establishing Liaison Groups in European Smart City projects

The Liaison Groups provide lighthouse cities with a seamless knowledge brokerage service to transfer and translate state-of-the-art knowledge into practice. To ensure that the local consortium partners in the lighthouse cities do not work in isolation, the groups are meant to engage peers in the other lighthouse cities, including those working in the fellow cities. This peer to peer learning enriches the design of smart solutions and improves their implementation processes. Furthermore, the lessons taken from the cross-city learning will also facilitate replication and upscaling of the solutions in the follower cities (Brno, Gdansk and Parma) and other EU-cities. From each lighthouse city (and local consortium) participants exchange their challenges and experiences and by doing so learn from each other. At the same time they help each other to analyse the elements that facilitate or hinder implementation of smart solutions and to articulate additional knowledge questions. The function of the Liaison Groups is not only on a practical level, but also on a more fundamental level of collaboratively building capacity to deal with complexity and urban innovation processes.

1.2 Smart City innovation and implementation framework

In the beginning of 2017 the Liaison Groups were involved in developing an ‘Overarching Innovation and Implementation Framework’ for smart cities (RUGGEDISED, 2017). For the Liaison Groups, the framework serves two main aims. First, it identifies the areas where the lighthouse cities require expert support and cross-city knowledge transfer. These are the enhancing and suppressing factors that the participants will continuously discuss. The knowledge partners will make sure that state-of-the-art knowledge feeds into the cities’ processes. Moreover, they will enrich the (academic) literature on smart cities by analysing and embedding the lessons learned from the Lighthouse cities. Secondly, the different impact levels (see figure 1: realisation and output, embedded outcome and replication and upscaling) and different components (hardware, software and orgware) serves as a structure to improve the integrated smart city design. The framework structure challenges participants of the Liaison Groups to think how implementation can

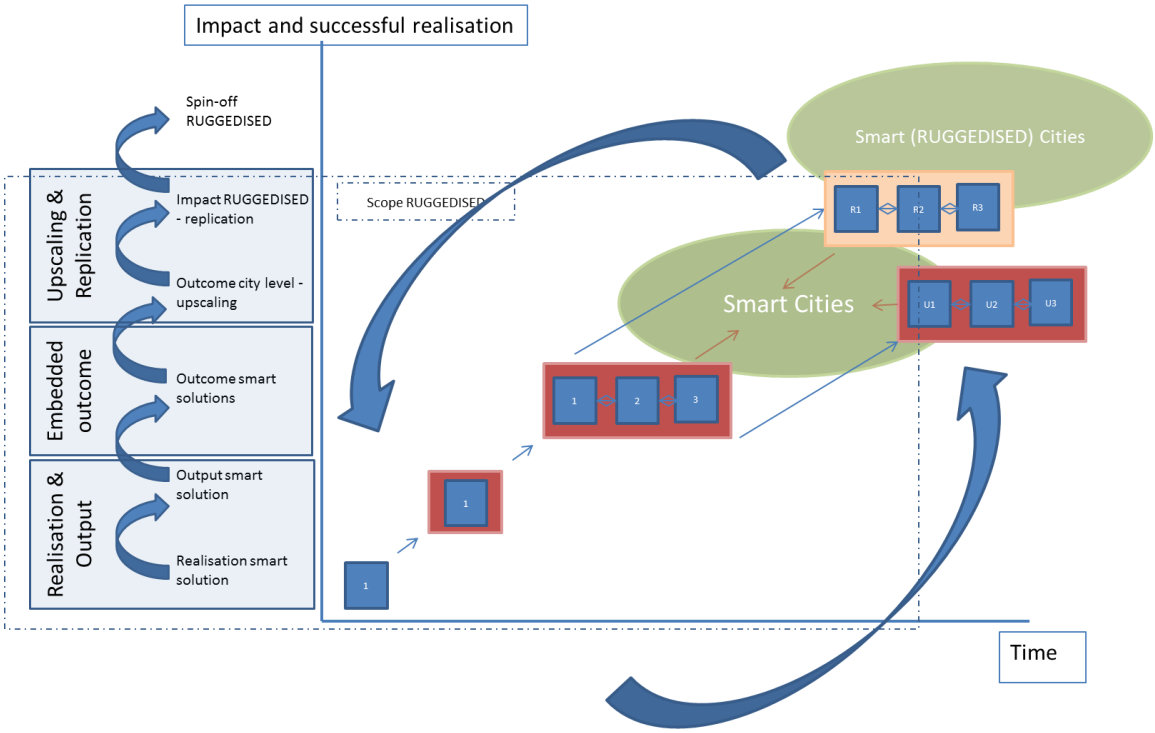

Figure 1 – Overarching Innovation and Implementation Framework (RUGGEDISED, 2017)

be embedded in the broader context of sustainable impact. The framework should stimulate a smooth knowledge brokerage process, and therefore it is crucial to jointly identify the issues at stake. A detailed subdivision between levels of impact and different components allows for such knowledge development and exchange.

Through distinguishing steps of realisation, we can structure the factors that influence the implementation of smart solutions and their level of impact. For instance, some factors primarily affect **realisation and output** and some specifically enhance or suppress that several solutions together result in **embedded outcomes**. Other factors are in particular relevant for **upscaling and replication**. The framework ideally works in such a way that each RUGGEDISED smart city solution can be assessed on its potential impact on different levels, while analysing in detail how enhancing and suppressing factors play a role for that particular solution. On the basis of such assessments, city planners and other actors can design a successful implementation process, assess the potential impact, and select specific aspects that need further consideration. It also works the other way around. Upscaling and replication is not something that comes after successful implementation. If real impact through upscaling and replicability is pursued, then factors that influence the success of upscaling and replication should be taken into consideration early in the process. For example, it might be problematic if a smart solution is fully-implemented without considering the requirements for successful upscaling or replication. From a RUGGEDISED or smart city perspective the impact of successful implementation would then be rather limited. During the Liaison Group meetings the framework serves as a reference. It allows TNO, as organiser, to reflect on the progress of the different implementation factors. Moreover it legitimises participants to broaden the discussion towards embeddedness, upscaling and replication, instead of discussing implementation hurdles on a very operational level.

1.3 Aim of this deliverable and reading Guide

This deliverable 1.1 is the first out of three reports discussing the 'lessons learned' from the Liaison Groups. Since it is the first report, it reflects on the functioning of the cross-city learning process in the Liaison Groups, rather than on the smart solution implementation processes itself. The deliverable includes the minutes of the Liaison Group meetings in the Appendix. The main body of the deliverable provides a reflection on and synthesis of the outcomes and functioning of the Liaison Groups.

2. The subtle art of knowledge brokerage - towards a methodoloy for cross-city learning

Ambitious innovation and implementation projects, such as RUGGEDISED, have at least two challenging and interesting features:

1. The smart solutions that the cities and their local consortia implement are highly innovative. That means that the involved actors can not rely on daily routines, but rather require processes of continuous pilotting, learning, trial and error.
2. The involvement of several partners and cities, that are experimenting with more or less the same innovations, allows to examine the success of different ways of implementation of smart solutions and the influence of different institutional contexts.

In order to fully exploit the potential of these two main project's features, dealing with knowledge is crucial. This section elaborates on the scietific base of cross-city learning in the RUGGEDISED Liaison Groups. It adresses three main topics: knowledge management, knowledge brokering and windows of opportunity.

2.1 About knowledge and learning

What kind of knowledge are we talking about? In general knowledge may be divided along two axes. The first axis distinghuishes between different types of 'what is known, the subject of knowledge'. On the one hand knowledge may refer to events and fact-based information (knowing *that*), and on the other hand it may refer to relational, procedural, and implementation related information (knowing *how*). The second axis refers to the 'transparency' and awareness/readiness of knowledge. Transparency both from the side of the owner of the knowledge (is he/she aware of the fact that he/she has this knowledge and that it drives its behaviour?) as well as from the side

	Knowing *that*	Knowing *how*
Explicit Knowledge	**Facts, events**	**Procedures, relationships**
Implicit Knowledge / Tacit Knowledge	**Mental models, causal relations, experiences,**	**Heuristics: the way in which mental models and convictions shape your actions: for instance drive decision making and define boundaries of the 'search for options'**

Table 1 - different types of knowledge

of the receiving partner. On this axis a distinction is made between explicit and implicit knowledge.

The initial idea of Liasion Groups is to cover all kinds of knowledge. Meetings should be on exchanging and sharing practical facts and experiences (explicit knowledge), but they should also engage participants towards reflection on what they are doing and what actually drives them (implicit knowledge). Discovering and sharing implicit knowledge improves mutual understanding. It is not only beneficial to the 'receiver' of the information, but also helps the 'sender' by learning

and understanding his incentives and dominant views.

Learning is a crucial element of the Liaison Groups. Here the definition of first order and second order learning is vital[1]. **First order learning:** Learning within the context of a given problem definition and about the analysis of the chosen solution for that problem, while retaining the underlying theoretical insights or deep convictions and values. **Second order learning:** The rethinking of dominant mental models and action models, particularly of theoretical insights and deeply rooted values and convictions.
The overall aim of the Liaison Groups within RUGGEDISED is to build a setting in which second order learning can be established.

2.2 Boundary work in smart cities

Key consideration for the communication in the Liaison Groups is that implementing innovations and improving urban systems can be succesfully done if not only the technical systems (resources, material aspects) are taken into account, but also their complex intertwining with the actors involved in maintaining and changing the system. The stakeholders' incentive structures may either originate from formal rules and institutions that guide actor's perceptions and activities, or from informal rules and behaviroual conducts.

Communication and learning in Smart City Lighthouse projects (within cities and between cities), such as RUGGEDISED, are characterised by several elements:

- Actors from different backgrounds and different expertises, having different expectations, come together.
- No single actor has the capacity to fully understand the entire system with all its complexity.
- Problems and challenges that stem from this complexity and intertwinement are usually not well defined or understood.
- Each actor builds on its own knowledge base (and its own understanding and demarcation of the system), which complicates the identification of collective knowledge gaps.

The Liaison Groups aim to facilitate the lighthouse cities in their endeavours to deal with this complexity. The methodologies that TNO applies in these Liaison Group meetings stem from scientific work on boundary spanning theory (see for instance Leifer & Delbecq (1978) and knowledge brokering in science-policy interfaces (see for instance Michaels, 2009). Slob and Duijn (2014) distinguish between six main concepts within boundary spanning theory (see figure 2).

[1] https://transitiepraktijk.nl/en/experiment/definitions

Premise	Communities are separated through boundaries that hamper communication and joint action
Boundaries	Perceived boundaries between communities that can be of different nature (organisational, cultural, geographical, etc.)
Boundary spanning	Activities that are undertaken to cross the boundaries, like communication or joint activities
Boundary objects	Tangible products of joint activities that satisfy the involved communities, like maps, action plans and policy notes. They contain knowledge and provoke action
Boundary spanners	People who cross the boundaries and intermediate between the communities. They are accepted in this role by the communities involved, for instance, because they are 'part' of the different communities
Boundary spanning processes	The processes that are needed to produce the boundary spanning objects with the communities involved

Figure 2 – concepts of boundary spanning (Slob & Duijn, 2014)

In order to deal with the complexity these authors stress the importance of collaborative knowledge development. For such a development there are four pre-requisites:
1. Joint production of documents, models, etc. ('boundary spanning objects')
2. People who can combine different fields of knowledge and can attach to different communities ('boundary spanners').
3. Legitimate and transparent processes to guide boundary spanning activities.
4. A joint ownership of the knowledge production process.

The Liaison Groups provide in these prerequisites, although it requires time and trust to build further on that. Within the Liaison Groups all participants have their own 'individual mental models', shaped by politics, culture, organizational contexts and personal experiences. The idea behind the cross-city learning is to transform these mental models into shared mental models, via group processes and the use of knowledge brokerage strategies. In general six types of knowledge brokerage / boundary spanning instruments are distinghuised (Magnuszewski et al., 2010, see figure 3). Section 3 of this deliverable describes how each method has been dealt with in the Liaison Groups so far.

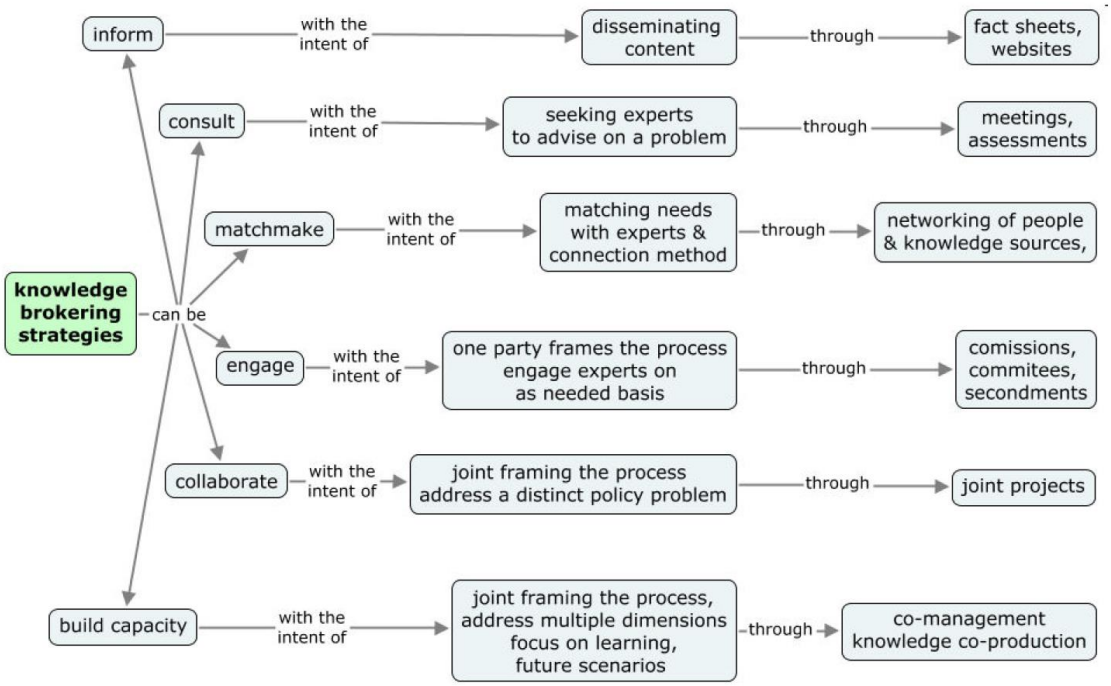

Figure 3 – Knowledge brokering instruments (Magnuszewski et al. 2010)

2.3 Windows of opportunity

A major part of dealing with smart city developments has to do with the sensitivity to windows of opportunity. Inherently, in smart city developments, many stakeholders, interests, policy domains and institutional settings are involved. In order to understand how such a complex structure may produce smart solutions, a better understanding of policy processes is helpful. The policy process has been described in a variety of ways, but one of the most influential frameworks is the Multiple Streams Framework[2], which is closely associated with the work of scholars like James March, Johan Olson and John Kingdon. The basic premise of the framework is that policy decisions should not be understood as fully rational attempts by political actors to deal with discrete societal problems, but rather as a set of largely independent streams which come together occasionally to produce meaningful change. Traditionally, decision making in institutions is viewed as a process that moves from problem definition, through extensive analysis to rational outcomes. In contrast to this view, the streams framework acknowledges that decisions are often made based on the availability of potential solutions, the perceived importance of a problem and a set of actors willing to bring those together. This description of the way in which decisions are actually made was first put forward by Cohen, March and Olsen's and called the "Garbage Can Model of Organizational Choice". The garbage can metaphor is based on the notion that potential interventions are proposed and discarded within many organizations, but emerge again once a particular problem becomes more acute, and decision-makers are looking for fixes. At that point, the decision-makers are more likely to pick something from the "garbage-can". This is especially the case under conditions of great uncertainty, since the ability to decide about a course of action is more difficult

[2] This section is cited from Magnuszewski P. (CRS), Sodomkova K.(CRAN), Slob A. (TNO), Muro M. (CRAN), Sendzimir J. (CRS) and Pahl-Wostl C. (UOS), 2010. Report on conceptual framework for science-policy barriers and bridges. Final version 22.12.2010 of deliverable No. 1.1 of the EC FP7 project PSI-connect. EC contract No. 226915. July 2010, Delft, the Netherlands. And from deliverable D1.2.

when it is completely unclear how to forecast its potential outcomes. John Kingdon applied this framework to policy communities, which include elected officials, but also agency staff, academics and advocates in a particular policy-area. In his influential book *Agendas, Alternatives and Public Policies*, Kingdon focuses on the "pre-decision processes", through which the agenda for decision-makers is set, and the process by which the alternatives that decision-makers choose from emerge. He describes these pre-decision processes which make up an important part of the policy process as follows: "We conceive of three process streams flowing through the system – streams of problems, policies and politics. They are largely independent of one another, and each develops according to its own dynamics and rules. But at some critical junctures the three streams are joined, and the greatest policy changes grow out of that coupling of problems, policy proposals, and politics." (Kingdon, 1995). The moment, or period during which these streams are coupled provide a window of opportunity for significant policy change. These policy windows are opened, according to Kingdon, "(…) either by the appearance of compelling problems or by happenings in the political stream." (1995: 20).

The theoretical reflections above show that policy making in general, and smart city developments in particular never start from scratch. They always result from history and interests brought from the different streams that together produce urban policies. That means that smart city design and smart city outcomes are often the result of path-dependencies and do not follow deliberate optimisation and rational processes. If we appreciate smart city policy making and the implemenation of smart solutions in such a way, it means that agenda setting in the Liaison Groups is sometimes ad-hoc, reacting on opportunities that show up. Moreover, it adds an additional layer to the challenge of capacity building in smart cities. Public administrators should not only engage in the process of knowledge brokering and sharing experiences, they should also train an awareness of seeking opportunities to connect different streams (i.e. policies and investments)

3. Lessons learned – reflections on the functioning of Liaison Groups

This section presents the lessons learned from the first year of RUGGEDISED Liaison Group meetings. It is structured along the lines that have been set out in the previous section. We start with a reflection on what has earlier been mentioned as the 'discovering' part of knowledge management. Then we elaborate on the different types of knowledge and the way in which they have been organized in the Liaison Groups. This results in a preliminary analysis of the different types of knowledge that the Liaison Groups bring together. What boundaries are there to span? What knowledge needs to be brokered? Finally we reflect upon the different knowledge brokerage strategies that were applied in the first year of Liaison Group meetings.

3.1 Agenda setting - discovering topics and participants

During the kick-off meeting of RUGGEDISED in November 2016 a first preparatory Liaison Group workshop took place. From a cross-city learning perspective, this meeting had two clear purposes: 1) to get a first overview of the variety of challenges to be discussed in the Liaison Groups (enhancing and suppressing factors to influence successful implementation of smart solutions) and 2) to decide on the participants of the Liaison Groups.

Ad 1) To prepare for the first discussion, TNO clustered the smart solutions to see the differences and similarities between the different cities. The participants discussed these similarities and differences and were asked to write down the potential enhancers and suppressors to successful implementation. This overview was the basis of the 'overall innovation and implementation framework' (deliverable 1.2) that was collaboratively developed. Moreover, it provided the agenda for the first Liaison Group meeting in January 2017, in which we broadly explored the implementation factors that were mentioned most by the partners: collaborative business models (orgware), user friendly interfaces (software) and the question how to choose between different technologies (hardware).
In the meetings that followed (Glasgow: June 2017, Amsterdam: November 2017) the Liaison Groups built further on these topics in two ways. First, the participants re(de)fined the topics and related challenges each time (for instance 'collaborative business models' became 'appropriate governance models for (smart) district heating systems'). Second, TNO changed the set-up regarding which city was asked to prepare the topic and discussion. This way we deliberately showed different perspectives and focus.

The aim of the Liaison Groups is to work 'on demand'. If the cities face challenges, they can circulate these within the group. Building on previous meetings and finding ways to open up the RUGGEDISED empirics into a collaborative RUGGEDISED perspective has been a successful approach so far. However, it is always good to engage on new topics. For instance, from the stories the cities told in the Glasgow meeting, it became apparent that the Liaison Groups needed to address issues on EV charging infrastructure. We explored this topic in the Amsterdam meeting and a follow-up took place in February 2018.

Ad 2) The Liaison Groups are explicitly meant to support cross-city learning from a public administration perspective. The original idea was to only include civil servants in the Liaison

Groups, for two reasons: 1) to ensure a similar level of expertise among the participants and 2) to create a place where participants can safely discuss the challenges they face, also with regard to cooperation with other (and private) partners in the consortium. However, the concept is flexible in that sense. From the beginning it became clear that Glasgow and Umea wanted to invite the private partners (such as Siemens and Umea Energi) each time a topic that was of interest to them was discussed.This resulted in the input of highly appreciated knowledge.

3.2 Types of knowledge and organizing the efforts

Section 2 described four types of knowledge (facts, procedures, mental models and heuristics). The aim of the Liaison Groups is to support cross-city learning. Learning, and deep understanding of the other cities' stories, requires the discovery of tacit knowledge such as metal models and heuristics. If the participants succeed in opening up tacit knowledge it will be informative to everyone in the group.

Until now, plenty of explicit knowledge exchange has taken place mostly on how challenges are dealt with in different institutional contexts (procedures). We did see hints of opening up tacit knowledge. The discussion on the Smart Thermal Grid in Rotterdam presented at the session in Amsterdam, provided Umea, Glasgow and Rotterdam, profound insights in the institutional drivers that are active in the background of the process. Although within a given setting the participants from Rotterdam are fulfilling their tasks (first order learning), during the Liaison Group discussion a more fundamental question was raised whether they are addressing the doing the right things and questions (second order learning).

In the next phase the challenge is to organise the knowledge that is exchanged and co-created during the Liaison Group meetings. The example from Rotterdam and the Smart Thermal Grid (STG) shows that it would be highly instructive to develop an institutional analysis of the heating system in the city, providing insight in the background drivers that are almost unnoticed, but crucial to understand the decisions of the Rotterdam partners. Other ways of organising (tacit) knowledge can be to draw concept maps that shed light on different perceptions of actors, or to map the causal relations within systems (systems thinking) to keep track of how different aspects influence each other. It can be also effective to organise knowledge according to different strategies and procedures that people drive (activity diagrams) or to focus specifically on ontologies and how actors see the relationship between different objects.

3.3 knowledge brokerage – what boundaries are there to span?

The cross-city learning process was stimulated by establishing three Liaison Groups (hardware, software and orgware). This was a deliberate choice to not let the differences between the participants be too big. Participants working on the same topic should easily find each other. It is interesting to see that during the last meeting in Amsterdam the orgware and hardware group were merged because the technical challenges were very closely related to the way in which systems are organised.

However, the first year of Liaison Groups still showed several boundaries to span:

The value of innovation. There is huge difference in how RUGGEDISED partners perceive the added value of innovation. This is not a problem on itself, as long as it is transparently discussed.

The aim of projects such as RUGGEDISED is to push innovative solutions towards upscaling and replication. Making mistakes is not problematic, as long as participants learn from them. Mistakes can enrich the process of upscaling and replication.

The significance of organisational and regulatory aspects in smart cities. Smart cities often focus on ICT and infrastructures. However, the challenges of governing smartness are underestimated. Moreover, the linkages between infrastructure and ICT decisions on the one hand and organisational decisions on the other hand, are very strong.

Ways of cooperation. The cities show great difference in the culture of public-private cooperation and the coherence of the local consortium. This is often a reflection of how the local social network is built up. Understanding each other's drivers of cooperation is key in cross-city learning. Different cultural backgrounds are not interchangeable, however this does not mean that there is nothing to learn from each other.

3.4 Knowledge sharing, using different strategies

As discussed in section 2, there are several strategies to effectively exchange experiences, share knowledge and broker between different institutional contexts: informing, consulting, matchmaking, engaging, collaborating and building capacity. In the first year of the RUGGEDISED Liaison Groups several of these strategies have been purposefully used by both facilitators as well as the participants themselves.

Informing usually takes place through typical dissemination channels, such as presentations, fact sheets and websites. Until now this strategy has not been used very much in the Liaison Groups, because it is mainly a one way type of exchange. We have considerably not chosen to rely on this approach because we would like the Liaison Group meetings to stimulate mutual learning.

Consulting is based on looking for experts to advise on specific problems within working sessions. This strategy typically works for cross-city learning purposes. The experts that cities are looking for come from the other cities and the knowledge institutes that are participating in the Liaison Group meetings. Consulting works very well if the challenge is well-prepared, clearly defined and well-presented to the experts. The discussions on district heating business models (prepared by Glasgow) and Smart Thermal Grid infrastructure (prepared by Rotterdam) have shown that the participants can give helpful insights to (partly) solve the challenges that the presenters are dealing with. One way to provide such helpful insights is to tell their experiences with a specific challenge. In doing so cities help to shed light on these challenges by opening up alternative perspectives. Such alternative perspectives usually cannot be simply translated to other institutional contexts. However, they provide clues to the presenters to search for ways of dealing with their challenges, for instance in widening scope.

Matchmaking is a strategy to facilitate networks of people and knowledge sources and match needs with experts. There have been several oportunities for 1-1 contact between the cities. The lighthouse cities have found each other on different topics. Moreover, two specific cases of 'matchmaking strategies' are worth mentioning. The EV charging challenges in Glasgow will be deepened in a working session with TNO and Dutch private partners (also outside the RUGGEDISED consortium). The specific challenges that Glasgow face are technical and practical.

For this working session, private parties invited are Dutch frontrunners on EV. In the second case, TNO experts (outside the RUGGEDISED team) have provided a calculation and modeling excercise to optimise the Smart Thermal Grid in Rotterdam. This study shedded light on the infuence of the design criteria that were taken for the development of the STG.

Engaging (working with comittees etc) is a strategy that typically refers to the involvement of external parrtners in the process of knowledge exchange. We used this strategy during the additional thematic Liaison Group meeting on EV charging. Here we invited Dutch front-runners (consultancies and knowledge platforms) to share their stories and experiences with the lighthouse cities. Some of these front-runners will stay connected to the process and will contribute to the collaborative outcomes in the future. In a sense they serve as a thematic committee.

Collaborating strategies rely on joint projects. This strategy consists in jointly framing the process of addressing a distinct problem. Within the Liaison Group on Software this strategy is currently being applied. The Lighthouse Cities develop collaboratively a micro-service that can be included in their ICT open data decision platforms.

Capacity Building strategies are based on co-management and knowledge co-production. Focus of capacity building refers to address multiple dimensions and develop mutual learning processes. The main tangible result of this strategy is the co-creative development of deliverable 1.2. This deliverable presents the overall innovation and implementation framework and includes a ‘RUGGEDISED’ knowlegde base on the implementation factors that were defined by the lighthouse cities (see table 2 on page 19). The framework and the knowledge base will serve as reference point and will be updated during the project. The implementation reports (by the lighthouse cities) will feed into the knowledge base as well.

3.5 Documentation of results

The outcomes of the Liaison Group meetings are documented in detailed reports of the meetings. TNO takes care of the the agenda setting (based on demand by the lighthouse cities) and the continuous character of knowledge exchange. This is done through frequent contact with the lighthouse cities, discussing their challenges and knowledge requests. Experiences, lessons learned and co-created knowledge from the Liaison Groups will be condensed in guidance in easy to read documents (Deliverables 1.6, 1.7, 1.8).

4. Lessons learned – the city perspective

The Lighthouse city coordinators reflected on the functioning of the Liaison Groups so far. This section presents their perspective:

In general, what is your perception of the cross-city learning process in the Liaison Groups so far?

[Rotterdam] This first year in Rotterdam was a year of finding out what to do and starting to work on the smart solutions. Our building partner Ballast Nedam, after approx. 6 months, didn't want to continue the development of the smart thermal grid. After several discussions, Eneco wanted to take over but only when there could be a positive business case for the thermal grid…..Eneco is still calculating to make the business more detailed and get it positive. No decision has been taken so far to really allocate tasks from Ballast Nedam to Eneco and Rotterdam (technical coordination). Too much time and attention was paid to this problem at the expense of paying attention to cross-city learning. Hopefully the present problems with Ballast Nedam and Eneco will be solved soon so that our attention to cross-city learning can be much more in the coming years. We believe cross city learning is indeed very useful. Face to face contacts in combination with informal talks is the best way to get to know and appreciate each other.

[Umea] It has been quite interesting with good discussion between the different cities

[Glasgow] The group has the potential to be very valuable. We are beginning to see more benefit through arranging very specific sessions outside of the Liaison Group in relation to smart solutions. The benefits are amplified through meeting face-to-face, however I acknowledge the financial impact of doing so.

Please elaborate one or two specific examples of 'lessons' you have learned from the other cities that are useful to your own practices?

[Rotterdam] One of the lessons is that all cities are organized differently and have their own specific problems. In Glasgow, like in Rotterdam, there are different owners of the existing electric and thermal energy infrastructures. Different owners make it difficult to realize only one smart thermal or electric grid. In Umea electricity is almost free and there are more EV charging points than cars. These differences open our eyes and give us a broader view on the smart solutions in Rotterdam.

[Umea] I would like to point out the discussions around smart heat grids, and how the design and setup heavily depends on regulatory aspects. Moreover, how these regulatory aspects also shape the discussion with city parners, I did find particulary interesting.

[Glasgow] We have learned lessons in relation to DH and EV, and we are only really starting to develop that further. My feeling is that now that we have identified specific points to discuss, we are able to begin extracting more value. We have also been able to offer help to other cities in the area of data. Again though, I feel that we are only

scratching the surface and will get more value as we progress talks.

What topics would you like to discuss in the upcoming period/year?

[Rotterdam] As far as it concerns the (Rotterdam) partners of RUGGEDISED: not all of them seem to understand that the EC grant will not cover all costs for realizing smart solutions. The obtained EC grant is only a contribution to the total costs. When making business cases the financial aspect is most important. It is very interesting to learn about what aspects do partners take into account when making business cases? What are the conditions that make business cases positive? And are partners willing to share their commercial thoughts and act transparent?

[Umea] Business Model Innovation around integrated energy systems, is still on top from my end.

[Glasgow] Battery storage/heat storage and/or dynamic governance in relation to smart city applications.

Do you have some ideas on how to improve/intensify the cross-city learning process?

[Rotterdam] We already emphasized that more technical talks and presentations will give Rotterdam partners a 'better feeling' about what is going on in the other cities. When there is more detailed technical knowledge about smart solutions in the other cities, the drive to talk to each other, as technical people, seems to become bigger.

[Umea] meetings are the best way, with workshops around interesting topics.

[Glasgow] I think subject specific workshops, with a tight agenda across a focused day will yield more results. In addition, I believe more side meetings may be required where the nature of the subject is specific only to a small group. I also wonder what research we could investigate as part of the process i.e. if there is a shared issue but not a shared solution, could we utilize the academic partners to initiate some research?

5. Conclusions and future process

The concluding section takes account of the implementation factors that were defined in deliverable 1.2. (RUGGEDISED, 2017). Table 2 shows which factors have been discussed in the Liasison Groups until now. Furthermore, two additional implementation factors are defined and elaborated. Finally, it suggests how the RUGGEDISED knowledge partners can disseminate the rich empirics in the lighthouse cities and contribute to the improvement of the smart city discourse.

Level of impact 1: Realisation and output of smart solutions					
Hardware		**Software**		**Orgware**	
Pre-deployment assessment		Privacy		Business models	x
Technology assessment		Security		Data and data ownership	
Impact on energy grid	x	Smart Grid ICT	x		
		User Interfaces	x		
Level of impact 2: Embedded outcomes of multiple smart solutions					
Hardware		**Software**		**Orgware**	
Communicating infrastructure		Interoperability		Integrated vision on the smart city	
Robustness of the system		Dashboards		Smart governance	
Existing infrastructures and vested interests	x			Windows of opportunity	
Project boundaries	x			Stakeholder management	
				Ownership	x
				Business models and split incentives	x
Level of impact 3: Upscaling and replication					
Hardware		**Software**		**Orgware**	
				Integrated planning	
				Innovation platforms	
				Conditions for upscaling: finance, regulation (including standardisation), access to information and social aspects	

Table 2 - Implementation Factors defined by the Liaison Groups (RUGGEDISED, 2017)

5.1 Framework update and topics to discuss

The discussions in the Liaison Groups and the collaborative session with WP 5 during the General Assembly in Glasgow enriched the overall innovation and implement framework that was developed in deliverable 1.2.

Here we discuss two implementation factors that can be added to the list of implementation factors (see table 2). Both 'Vested Interests' and 'Project Boundaries' can potentially enhance or suppress the implementation of smart solutions.

Additional Implementation Factor: Vested interests - dealing with existing urban (infrastructure) context

The implementation of smart solutions most often takes place in existing urban areas. That challenges not only the physical connection to existing infrastructures but also the way in which they influence each other. This most prominently is the case in Rotterdam

In Rotterdam, a great deal of the city is connected to the district heating, fed-in from a waste incineration plant in the Port of Rotterdam. Within the RUGGEDISED project in the Hearth of South area, a Smart Thermal Grid (STG) (exchange of heat and cold between several buildings including pavement water and sewage) is developed. In both financial terms as well as energy demand the STG competes with the district heating system. The more efficient and effective the heat provision to the buildings by the STG is, the less these buildings rely on the district heating network. Optimizing the STG in the Heart of South district decreases heat demand in the area and, thus, from the existing district heating network. The lower the demand, the higher the price that the energy company of the existing district heating network is going to charge (peak tariffs). These alternative costs are now putting the business case of the STG under pressure. Moreover, for the technical design, several criteria were taken into account. One of the major design criteria or requirements was to avoid these high tariffs.

As turned out in retrospect, the existing district heating infrastructure governance in Rotterdam should have been considered more in depth. It is a profound boundary condition for the planning of the STG and has significant influence on the size and optimization of the grid. From the discussions in the Liaison Groups it became clear that in terms of 'lessons learned' it is crucial to clearly define smart solution goals beforehand. For instance, should the STG development prove the success of a highly innovative smart grid technology, should it help to optimise the carbon reduction in the area, should it be an experiment to couple new and existing infrastructures, should it prove that it can deal with multiple feed-in or is it a pilot that can be adapted and upscaled in a later phase? Once set clear goals, involved actors can more easily take eventual losses for granted.

Additional Implementation Factor: Project boundaries

Related to the implementation factor on 'vested interests' is the issue of (flexible) project boundaries. Due to the optimisation of smart infrastructures – from a financial, technical and sustainability point of view – very often the solution for dealing with specific challenges is to adjust project boundaries (physical and geographical, less or more stakeholders involved, regulatory flexibility, time schedules). Flexible project boundaries are not something project managers are particularly keen on, because their perception of flexibility is related to additional risks. Firstly it will be a challenge to develop ways to openly discuss whether a chosen project demarcation works

well or not. Secondly RUGGEDISED partners can come up with ways to actually deal with more flexibility in project demarcation. This topic will be discussed in the upcoming period of the Liaison Groups.

5.2 Future process

The RUGGEDISED partners succeeded in getting the Liaison Groups up and running. In particular, this process showed that cross-city learning is of interest to everyone, and it also showed that it takes time to get to know each other and to appreciate each other's backgrounds.

The aim for the upcoming period is to proceed with the way in which the Liaison Groups currently run. However, while exchanging lessons learned stays important, the focus will slightly shift towards capacity building and collaborative knowledge developement. Together with the participants we want to improve the capacity to deal with complex (socio-technical) systems and their challenges, especially regarding understanding the diversity of the system, opening up windows of opportunity, identifying knowledge gaps and filling these with collaboratively developed knowledge.

On top of that, we aim to produce tangible results that can be disseminated among the entire smart city network, via other SCC01 projects and the EIP Smart Cities Market place.. Based on the synthesis of the RUGGEDISED experience and knowledge we aim to produce factsheets/articles on the following topics:

- The governance of smart energy infrastructure (with explicit focus on the relation between existing and newly developed infrastructure)
- The EV readiness level of cities: a detailed guide towards city-wide implementation of EV (with explicit focus on EV-charging infrastructure; the decision that has to be made and the actors the needs to be involved)
- Collaborative business models for smart ICT platforms, in cooperation with WP 6 (Upscaling)

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Appendix List

1.	Minutes of the Liaison Group Kick-off in Rotterdam 2016	9 – 10 November
2.	Minutes of the 1st Liaison Group meeting in Delft	30 – 31 January 2017
3.	Minutes of WP 1 – WP 5 Workshop in Glasgow	13 June 2017
4.	Minutes of the 2nd Liaison Group meeting in Glasgow	15 June 2017
5.	Minutes of the 3rd Liaison Group meeting in Amsterdam	7 – 8 November 2017

Appendix 1 - Minutes of the Liaison Group Kick-off in Rotterdam (9 – 10 November 2016)

Ruggedised Kick-off 8-10 | November 2016 | Rotterdam
WP1 parallel session on 9 November |TNO - Adriaan Slob & Alexander Woestenburg
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Activities within WP 1 will focus in the first year on (i) developing a smart city innovation and implementation framework, (ii) establishing liaison groups in the three Lighthouse cities of the project (Rotterdam, Umea and Glasgow), and (iii) facilitating a learning process between these cities to support implementation of smart solutions.

Smart city innovation and implementation framework

The smart city innovation and implementation framework that will be developed in the first 6 months of the project will provide a clear definition and operationalization of smart cities. It addresses the main technical and socio-economic challenges and contextual factors that influence (hampers or enforces) local innovation and the implementation of smart solutions in each of the lighthouse cities. The framework allows to:

- Identify areas where the lighthouse cities require expert support and/or cross-city knowledge transfer (WP 2-4)
- Embed individual smart city solutions and knowledge development in the bigger picture of smart city innovation
- Create a knowledge base by describing the state-of-the-art and next steps
- Address specific topics that are relevant to be monitored (WP5)
- Implement the smart city solutions in a more or less comparable way, to ensure deployment and replicability (WP6&7)

Liaison groups

The framework is an important basis and guideline for the thematic liaison groups that will be established. To ensure that the teams in the lighthouse cities that are involved in the design and implementation of the smart solutions do not work in isolation, the liaison groups will provide them with a seamless knowledge brokerage service to transfer and translate state-of-the-art knowledge and to engage peers in the other lighthouse cities, including those working in the follower cities.

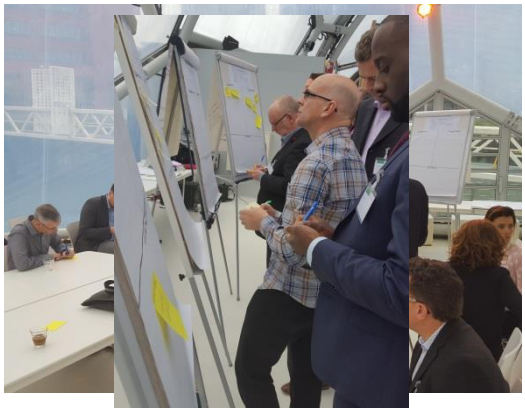
Three thematic groups will be formed, on hardware (Energy and E-mobility), software (ICT, data and management), and orgware (governance, stakeholder involvement, business models, etc.). In each group one person from each city will join, in order to explore the different themes across city experiences. Since each city is supported by one of the partners: Glasgow by US, Umea by SP, and Rotterdam by TNO, these partners will also be part of the liaison groups. The liaison groups will meet twice a year. Sometimes they meet all together or only with the specialists of one of the tracks.

Parallel session during the kick-off

During the parallel sessions both cities and other project partners were asked to brainstorm on the main items that will potentially enhance or suppress the implementation of the smart city solutions in the lighthouse cities. These enhancers and suppressors will not only be addressed in the innovation and implementation framework, they will also be put on the agenda of the liaison groups meetings. We divided the smart city solutions into four categories: Smart Electro Mobility, Energy Demand Side Management, Thermal Grids and Heat / Cold Exchange, and ICT Platforms. An overview of the projects belonging to each of these categories are included in appendix A. We asked

the participants to indicate the similarities between the projects in each city as well. An overview of the enhancers, suppressors and similarities is included in appendix B.

Finally, we made an inventory of potential participants for the liaison groups (see appendix C).



Conclusions - themes extracted from the post-its and subsequent discussion

Summarizing the enhancers, suppressors and similarities, at least the following topics will be addressed in the innovation framework and the liaison groups:

Electricity infrastructure network. Local sustainable energy supply and the potential of demand response require the energy infrastructure to adapt. The capacity of the current infrastructure systems might be extended (or can be declined?). We need to carefully calculate what the consequences of the Ruggedised related investments are on the infrastructure network. Involvement of the infrastructure owners/operators in an early stage is crucial. Is this sufficiently addressed in all cities?

Stakeholder engagement. The involvement of stakeholders is a crucial element in smart city developments. Stakeholder engagement requires a carefully designed process as a large number of stakeholders can both be a risk and an enhancer for successful implementation of all smart city solutions.

Understanding the management system of demand side management solutions. Demand side management systems require engagement and understanding by the end users of the system. If they do not understand the working of the system or do not perceive it as useful, the system will not work. It is a challenging task to design a well-functioning, with a simple and usable interface.

Data, software, access and ownership. ICT applications both need and produce a lot of (open)data. It concerns public, private and societal data with different data regimes, quality and levels of confidentiality. Moreover, the platform applications rely on data alignment and – exchange. Policy decisions made on the basis of big data and ICT applications may have (severe) consequences for several stakeholders involved. Questions as to how to deal with these data and decision platforms in

terms of ownership, user rights, privacy, supervision, subsequent risks, business case, benefits etc. need to be addressed and discussed in the liaison groups.

Business models. Business models are a very important aspect in the development of smart cities. These business models not only need to deal with innovative techniques, but also with multi stakeholder arrangements/dependencies and split-incentive dilemmas. Moreover, an important aspect here are national and local subsidies on sustainable (or carbon) energy and to what extent smart city solutions rely on such subsidies. Policy changes may affect the implementation.

Replicability / uniqueness of solutions. In order to profit from economies of scale and enhance the learning effects across the cities it is important to design and implement smart city solutions in a comparable way. For this, it is crucial to record learning experiences.

Timing and alignment with existing projects and time schedules. This is a crucial aspect in the smart cities domain. Enhanced connectivity between different parts and projects within an area requires careful time management and organizational alignment of separate projects. The aim is to collaboratively plan, design, act and operate.

ICT platforms as decision support tools. Each city aims to develop an ICT platform as real-time decision support tool. There are several challenges here related to data sharing and data quality. However, main challenge in each city is to develop the tool in such a way that it answers to urgent societal issues and that it's mechanisms and outcomes are understandable for the users.

Data, information and cybersecurity. This is an important topic that should be addressed. Smart City solutions are based on public/private/open/big and linked data. The quality of the data, availability of meta data and the level of openness are key drivers to successful translation of data into valuable policy information. Cybersecurity will be addressed separately.

Thermal grids. All cities will have to deal with technical issues and business case related challenges regarding thermal grids, heat-cold exchange etc. The business case and governance model necessary to exchange heat at area level, will be part of the liaison groups.

Next meeting

WP 1 will organise a meeting on 30-31 January 2017 in Delft. On Monday 30 January the first meeting of the liaison groups will be held. Moreover we will discuss the draft innovation and implementation framework. Tuesday 31 January, we will explore the linkages between the work packages with WP 5, 6, 7, and 9.

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Appendix A Smart City Solutions

Energy: Thermal grids & heat-cold storage / exchange

Rotterdam		Umeå		Glasgow	
R1	**Geothermal heat-cold storage / heat pumps** Elaborate a heat-cold storage and exchange system based on a low-temperature thermal grid. Connects all existing and some new buildings.	U2a	**Peak load variation management and power control** Using buildings as thermal energy storage	G1	**Heat-cold exchange: connection of buildings to district heating network** Use surplus heat and develop business models to exchange heat
R2	**Thermal energy from waste streams** Optimally use thermal waste streams (swimming pool, sewage, cooling systems)	U3	**Geothermal heat-cold storage and exchange** Develop a business model for sharing of a geothermal heat-cold storage. Mapping the exchange of heat and cold in the smart network.		
R3	**Surface water heat-cold collection** Surface water will be used to add heat to the storage system in order to create a balance in the smart geothermal energy grid				
R4	**Pavement heat-cold collector** Building a heat exchanger under the surface in the road to balance the geothermal heat-cold storage system				

Energy: Smart EV charging and e-mobility

Rotterdam		Umeå		Glasgow	
R5	**DC grid, PV and storage for mobility** PV energy distributed to battery storage for local/direct use by e-bus fleet	U6	**E-charging hub** Advanced monitoring and governance systems, test different batteries and dynamic payment systems	G2	**Battery storage as grid balancing mechanism and supply of RES to EV charging**
R6	**Smart charging parking lots** 2 way energy flows to minimize peak loads	U7	**Flexible Green Parking pay off** Reduction of car parking space and shifting (private) investments towards sustainable mobility solutions	G3	**Surplus power storage in EV charging hub battery storage** Technological challenge to distribute energy from CHP to battery storage for later use in city systems.
R7	**Energy Management/ Electric buses** The challenge and innovation is to introduce zero emission (e)-buses successfully on a large scale, with the same reliability of the timetables of the public transport.	U5	**Energy optimized electric BRT-station** "Bus rapid transit station" hub with shelters, heating systems, an intelligent ticket identification system using smartphones before boarding.	G4	**Optimisation of near-site RES** ensure that as much of the renewable energy generated is used locally within the district
				G5	**EV charging hub in the city centre car park** Business case for concentrated deployment of EV chargers.
				G6	**Intelligent LED street lights with integrated EV charging**

					Business case to exploit demand side management

Energy (demand side) management

Rotterdam		Umeå		Glasgow	
R11	**Efficient and intelligent street lighting** Centrally managed adjusted intensities	U2b	**Peak load variation management and power control** Automated energy management	G8	**Implementation of demand-side management technology in street lighting** Central management system controlling demand side events
R13	**Smart waste management** Smart waste traffic to lower energy use of vehicles for waste collection and using sensors to measure the degree of filling of the containers.	U4	**Intelligent building control and end user involvement** Continuous analysis of energy performance, integrated control systems	G9	**Implementation of demand-side management technology in domestic properties** Demand side management events that benefit both the grid and the residents
				G10	**Implementation of demand-side management technology in non-domestic properties** Demand side management events that benefit both the grid and the energy use and efficiency of the buildings

ICT and management of data

Rotterdam		Umeå		Glasgow	
R8	**Energy Management** Manage all energy streams: maximize RES and prevent energy loss. Share of data via smart metering and smart coupling of the building management systems.	U1	**Smart City connection to 100% renewable energy** Optimization from an overall perspective, further develop the monitoring, power quality, prevent disruptions.		.
R9	**3D City operations model** The data on the use of energy of the buildings will be matched and transferred into a new 3-D city operations model. This 3-D model functions as an open data-platform and makes further innovation possible by making data available for everyone.	U8	**Smart Open Data city Decision platform** Integration of existing and new ICT solutions into a Smart City Data infrastructure based on Open Data principles, and connection to a City Decision Support platform.	G7	**Smart open data decision platform** Creation of a query based geo-spatial 'Data Based Decision Platform' (DBDP) that will collect data related to city management (e.g. energy, air quality, traffic flow, etc) to enhance energy planning in the city
R10	**LoRa-network** Network to increase efficiency of data transport. It allows for all kinds of sensor techniques.				
R12	**Nerdalize eRadiator** Sustainable and affordable high-end compute platform				

Appendix B Enhancers, suppressors and similarities

Thermal grids / Heat cold exchange - enhancers

Enhancers	Related measure	Related City	Name	Theme
Emerging national policy		Glasgow		Urgency | Institutional context
Energy policy on low carbon and energy performance		Rotterdam	Roland van Rooyen - Rotterdam	Urgency | Institutional context
Existing District Heating Network		Rotterdam	Roland van Rooyen - Rotterdam	Timing
Different phases in implementation of geothermal energy storage in 3 lighthouse cities, possibility to learn from each other			Jakob Odeblad - VCC	Available expertise and learning potential
Good existing expertise and examplar systems			Kelly Cotel - ICLEI	Available expertise and learning potential
Cooperation in partnership, technological readiness		Rotterdam	Jasper Feuth - Eneco	Available expertise and learning potential
Cooperation in partnership, technological readiness			Jörgen Carlsson - Umeå Energi	Available expertise and learning potential
Procurement phase is already done in Rotterdam		Rotterdam	Jasper Feuth - Eneco	Timing
Available technology. Grid to Grid connecting buildings. Building process		Rotterdam	Dion Cools - Rotterdam	Available expertise and learning potential

Thermal grids / Heat cold exchange - suppressors

Suppressors	Related measure	Related City	Name	Theme
Existing UK Energy system		Glasgow		Urgency | institutional context
Partly fossil based obligatory connection to district heating for new building		Rotterdam	Roland van Rooyen - Rotterdam	Institutional context
Stakeholder discussions, who benefits		Rotterdam	Dion Cools - Rotterdam	Stakeholders
Business pay back period > 20y		Rotterdam	Jasper Feuth - Eneco	Business model
Stakeholder coming together		Rotterdam	Jasper Feuth - Eneco	Stakeholders
software energy distribution platform at area level		Rotterdam	Jasper Feuth - Eneco	Technical challenge
unclear business mechanisms, risk mitigation		Umea	Jörgen Carlsson - Umeå Energi	Business model
infrastructure costs in old cities, demand management conflicts, better approaches are available			Joe Clarke - University of Strathclyde	Business model
How deep would heat exchanger be? What about impact of roadworks?	R4	Rotterdam	Stephen Peacock - Scottish Power En	Technical challenge
Hard to evaluate results during the project time (energy performance)			Jakob Odeblad - VCC	Evaluation and monitoring

Thermal grids / Heat cold exchange - similarities				
Similarities (also with regard to follower cities)	**Related measure**	**Related City**	**Name**	**Theme**
The need for business models		Glasgow		Business models
Get grip on energy prices, by lowering use of fossil fuels		Rotterdam	Roland van Rooyen - Rotterdam	Business models
Business models involving energy companies				Business models
Northern European similar heat requirements and patterns			Kelly Cotel - ICLEI	
Similarities in buildings/ tenants, universities, hospital, public private			Jakob Odeblad -VCC	Institutional context | stakeholders
Many similar preferences, similar demands		Umea	Jörgen Carlsson - Umeå Energi	
Lessons learned R2, R3, R4		Follower city		
Centralisation versus decentralisation of heating network		Brno	Lukáš Grůza - Brno	Technical challenge
Business models	U1	Brno	Lukáš Grůza - Brno	Business models

Smart EV - enhancers

Enhancers	Related measure	Related City	Name	Theme
Policy on good air quality (zero emission)		Rotterdam	Roland van Rooyen	Institutional context
Another project between municipality of Umea, Akademiskahus and IKEA is to build a cargo hub, share collaboration.		Umea	Olov Bergstrom - Akademiskahus	Show case | timing | alignment
A very good collaboration climate in the university city of Umea Group		Umea	Olov Bergstrom - Akademiskahus	Stakeholders | end user
Smart alghorithms needed		Rotterdam	Marcel van Oosten - Erasmus	Technological challenge/readiness
New business models		Rotterdam	Marcel van Oosten - Erasmus	business case
(Accepted) standards		Rotterdam	Marcel van Oosten - Erasmus	Alignment
Modern and quiet equipment can improve quality of public transport		Rotterdam	Dion Cools - Rotterdam	Performance
Higher status of public transport, visable smart solution (BRT station)		Umea	Carina Aschan - Umea	Performance
Vehicle2Grid technology working		Rotterdam	Marcel van Oosten - Erasmus	Technological challenge/readiness
New areas young people open to new behaviour		Umea	Carina Aschan - Umea	Stakeholders | end user
Need to consider the EV-driver and their behaviour				Stakeholders | end user
We need to promote the services to EV drivers and seek their feedback				Stakeholders | end user
Quick moving market and a demand from the public		Umea	Jorgen Carlsson - Umea Energi	Stakeholders | end user
City / regional policy, decreasing prices of technology, nationa programs for stimulation		Rotterdam	Virgil Grot - RET	business case
If the services are not designed with the user in mind then we will not fulfil the projects potential				Stakeholders | end user
Lead-in timing. For installation of charge points can easily be delayed. Need to plan accordingly				Timing
Extra investments DC net are hard to be earned back by less energy usage		Rotterdam	Jasper Feuth - Eneco	business case

Smart EV - suppressors				
Suppressors	**Related measure**	**Related City**	**Name**	**Theme**
Impact on Infrastructure		Glasgow		Electricity Infrastructure network
Networking company: cooperation needed		Rotterdam	Roland van Rooyen - Rotterdam	Electricity Infrastructure network
Preference for home charging, problems over access to charging points				Stakeholders
LV capacity limits and costs				Electricity Infrastructure network
Reliability and performance, low rate of transport replacement, need for hybrid solutions		Glasgow	Joe Clarke - University of Strathclyde	Performance
E-mobility in the netherlandse because tax benefits are gone		Rotterdam	Jasper Feuth - Eneco	Business case
Concentrated EV may have big impact on local LV distribution network especially if rapid charging and high demand are utilised	G5	Glasgow	Stephan Peacock - sp energy networks	Electricity Infrastructure network
As more complex energy storage technology schemes are implemented there will be a challenge in optimising and contribution	G3	Glasgow	Stephan Peacock - sp energy networks	Electricity Infrastructure network
Acceptance and involvement of end users / drivers		Rotterdam	Marcel van Oosten - Erasmus	Stakeholders | end users
the impact on the electricity network, reinforcement costs				Electricity Infrastructure network
Reliability of the equipment of e-busus and the ICT		Rotterdam	Dion Cools - Rotterdam	Performance
Public lack of knowledge, financial, reliability of the technology		Rotterdam	Virgil Grot - RET	Expertise
Too much focus on technology, social and organisational aspects could slow things down				Stakeholders

Smart EV - similarities				
Similarities (also with regard to follower cities)	**Related measure**	**Related City**	**Name**	**Theme**
Battery storages charging bikes and cars (in the U6 project we will also install solar panels	V6 + G2 + G3 + R5	Umea	Olov Bergstrom - Akademiskahus	
How to organize and optimize car sharing in the city		Parma?	Evgenia Capone - Infomobility	upscaling
We need to agree between cities what do we mean by SMART				alignment
We need smartness of the system		Rotterdam	Marcel van Oosten - Erasmus	alignment
Relatively new territory, flexibility to alter choices				
buses / taxis?				upscaling
What are the barriers for e-mobility to further develop?		Parma	Evgenia Capone - Infomobility	upscaling
Does a business model exist to enlarge the charging points		Parma	Evgenia Capone - Infomobility	Business case
G5 and G6		Brno		

Demand side management - enhancers

Enhancers	Related measure	Related City	Name	Theme
Informed and engaged citizens and businesses		Glasgow		Stakeholders | end-users
Real time energy pricing to stimulate peak shaving		Rotterdam	Roland van Rooyen - Rotterdam	Technical challenge
Alignment with existing projects		Glasgow		Timing
Timing	R4, U2b U4 G8 G9 G10		Tobias - Erasmus	Timing
Data access and sharing				Ownership
User motivation and engagement drops over time continuous assets are necessary	U4		Gudrun Hain dlmaier - AIT	Stakeholders
Need DSM-devices or Apps to detect preferences		Rotterdam	Marcel van Oosten - Erasmus	Technical challenge
Involving users in development of DSM solutions				Stakeholders | end-users
Visibility of data entrances; understanding of incumbent control system, building of platform within dedicated team		Glasgow	Andrew Smith - Siemens	Stakeholders | end-users
Combined business case multiple loads using some comms / same control interface				Business case
Strong stakeholder engagement - always make building owner/ manager know them have ultimate control				Stakeholders | end-users
Replicable solutions, DSM interface, shared comms infrastructure save money and improve reliability				Replicability
Large loads, single owner of large estates (local council) good comms				Stakeholders | end-users
young people in new flats, wanting tech also open to charge (behaviour)			Carina Aschan - Umea	Stakeholders | end-users
ICT solutions to communicate impact				Show cases
Communication with large tenants				Stakeholders | end-users
Reliability of system, acceptance of innovative technology		Rotterdam	Dion Cools - Rotterdam	Performance

Demand side management - suppressors				
Suppressors	**Related measure**	**Related City**	**Name**	**Theme**
Timing				Timing
Data access and sharing				Data ownership | Alignment
User motivation and engagement drops over time continuous asses are necessary				Stakeholder | end-users
Ownership of data and software		Rotterdam	Jasper Feuth - Eneco	Data ownership | Alignment
System security, user perception that their building susceptible to 'attack'				Security
Market differentattions within cities; business models defined around country specific requirements (RoI & Pay back)			Andrew Smyth - Siemens	Business model
Reliability of the system. Baseline guaranteed?		Rotterdam	Dion Cools - Rotterdam	Performance
Stakeholder engagement; champions within organisations to support innovative implementations. Management of explications throughout complex organisations			Andrew Smyth - Siemens	Stakeholder | expertise
Communication with large tenants				Stakeholder
Poor Comms, poor understanding of load reduction that is realistic				Stakeholders | end-users
Lack of end-user, buy-in, drop-out over time from DSM				Stakeholder | end-users
Lack of available load,thermal capacity				Technical challenge
Complexity of alghorithms, dynamic /stochastic nature of demand and supply, no agreement on control centre.			Joe Clarke - University of Strathclyde	Technical challenge | performance | experti

Demand side management - similarities				
Similarities (also with regard to follower cities)	**Related measure**	**Related City**	**Name**	**Theme**
The city of Tarty, Estonia, has recently established such a solution maybe that will give you helpful inspiration.	R11		Gudrun Haindlmaier - AIT	Show cases
Data sensitivity and security, anonimity of data, approval to share data, at what frequency and what format?			Andrew Smith - Siemens	Security
Data available and data required, understanding what info is required to deliver outcomes, too much versus too little			Andrew Smith - Siemens	Data ownership | Alignment
baselining - suitability of existing data to analyse improvements/ changes going forward througout implementation			Andrew Smith - Siemens	Data ownership | Performance

ICT platforms and big/open/linked data - enhancers

Enhancers	Related measure	Related City	Name	Theme
Assigned contact board or person for management of data with sufficient personal to collect and process available data	G7	Glasgow	Gudrun Haindlmaier - AIT	expertise
In house expertise in relation to development		Glasgow		expertise
Participation in decision making process , real impact by citizens	U8	Umea		Stakeholders
Motivation and time / duration start and (too Long) for citizens	U8	Umea		Stakeholders
Involving stakeholders with big impact or who represent real interests of citizens	U8 and G7	Umea and Glasgow		Stakeholders
Reliability of ICT tools, collecting useful data		Rotterdam	Dion Cools - Rotterdam	Performance
Stakeholder analysis first		Rotterdam	Marcel van Oosten - Erasmus	Stakeholders
Fast start-ups			Klaus Kubeczko - AIT	Show cases
Low bandwidth data requirement: don't ask for too much data				Technical challenge
Common standards			David Carlsson - Akademiskahus	Alignment
Visualization concreate examples of the use of open data			Carina Aschan - Umea	Show cases

ICT platforms and big/open/linked data - suppressors

Suppressors	Related measure	Related City	Name	Theme
Quality of the data and meta data		Glasgow		Data
Data overload. Perception and benefit		Glasgow		Technical challenge | stakeholders?
Use cases / added value	R9	Rotterdam	Tobias - Erasmus University	Show cases
Difficult to integrate different data into 1 joint platform, different software, different data collection different city administration departments, collaboration	G7	Glasgow	Gudrun Haindlmaier -AIT	Alignment
Governance and designs of data platform		Rotterdam	Marcel van Oosten - Erasmus	Alignment | Ownership
Reliability of ICT tools, collecting useful data		Rotterdam	Dion Cools - Rotterdam	Performance
How open should it be and to whom		Rotterdam	Marcel van Oosten - Erasmus	Ownership
Ownership of the software		Rotterdam	Jasper Feuth - Eneco	Ownership
Data protection, threats to critical infrastructure and public acceptance			Klaus Kubeczko - AIT	Security
Multiple actors wanting to use data				Stakeholders |Ownership | Alignment
Uncertainty regarding who owns the data			David Carlsson - Akademiskahus	Ownership
No proven big data platforms, no connected apps and management mechanism			Joe Clarke - University of Strathclyde	Show cases
Authentication & cybercrime				Security
Domestic properties (personal data) and multiple systems (bringing data together)				Alignment | Ownership

ICT platforms and big/open/linked data -				
Similarities (also with regard to follower cities)	**Related measure**	**Related City**	**Name**	**Theme**
Understanding the value of data		Glasgow		Data --> information | business models
Link in with existing lighthouse cities			Helen Franzen - ICLEI	Show cases | Alignment
All cities want to implement a data platform			David Carlsson - Akademiskahus	Platform
Lessons learned. Open data platform BIG DATA		question by follower city		
Lessons learned, how to integrate GIS from different cities companies		question by follower city		
G7, R8, R9, U8		Brno		

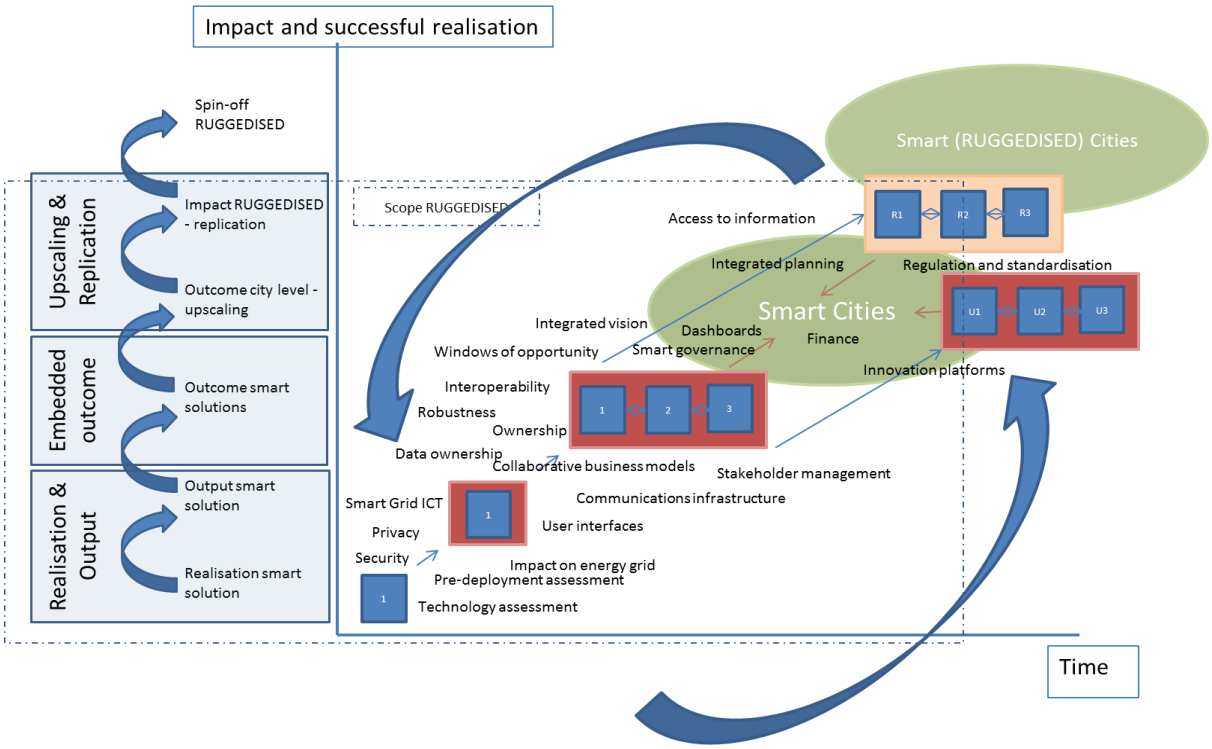
Appendix 2 - Minutes of the WP 1 – WP 5 meeting in Glasgow (13 June 2017)

RUGGEDISED GA meeting | June 2017 | Glasgow
WP1 -WP 5 parallel session on 13 June

TNO - Adriaan Slob & Alexander Woestenburg
AIT – Hans-Martin Neumann & Ghazal Etminan

"Expect the Unexpected"

In Deliverable D1.2, together with many RUGGEDISED partners we developed the Smart city innovation and implementation framework. This framework highlights the factors the can potentially enhance or suppress the implementation of smart solutions in Lighthouse and Fellow cities. The Smart city innovation and implementation framework is aimed at managing these challenges through building awareness concerning the factors that could suppress or enhance implementation and providing relevant knowledge to tackle these challenges.



Looking at all implementation factors it is evident that the more the focus shifts towards the levels of smart city outcome, upscaling and replication, the more the enhancers and suppressors have a 'softer' orgware character. This finding is relevant for at least two reasons. Firstly, these soft process factors often gain less attention in urban development, especially as it concerns highly technological innovative projects. Secondly, factors such as cooperation, stakeholder management and business models are important for upscaling and replication. These factors are very receptive to local urban contexts, which could hamper replicability in a one to one manner. Often these aspects need to be tailored to the specific urban context.

The overview of relevant aspects in this report shows a wide variety of implementation factors that enhance and suppress implementation of smart city solutions. Dealing with these factors requires an interdisciplinary

and integrated approach towards city development which may have its consequences for how cities are organised at this moment. Very often they still rely on a departmental organisation that hamper the integrated approach. Interdisciplinarity and integrated planning are profound challenges. This does not only concern alignment and sharing of knowledge, but first and foremost this requires collaborative knowledge *development* and developing a common vocabulary: learning how to manage the smart city together is an important challenge for smart city implementation. This requires a continuous learning cycle towards better policy making, instead of a linear process (realisation → collaborative outcomes → upscaling and replication). It is rather a continuously iterative process of checking whether what is being done fits the overall perspective of upscaled and replicated smart cities.

The conclusion from D1.2 that many implementation factors concern softer process characteristics leads to the questions of how to keep track of these aspects during the process and how to build some kind of 'early warning system' in case these aspect are likely to hamper the implementation process. The aim of the combined WP 1 -WP 5 workshop was to collaboratively discuss how the cities can improve their continuous learning capacity by being aware of „The Unexpected". Improving this awareness may lead to a changing perception of unexpected events, from it being a risk towards turning it to be an opportunity.

Each city discussed the following issues:
Unanticipated problem definitions
Unanticipated impact / multiple value creation
Unanticipated stakeholder interests
Unanticipated (un)availability of knowledge
Unanticipated changes in personnel
Unanticipated political behaviour
Unanticipated financial sources, costs or revenues

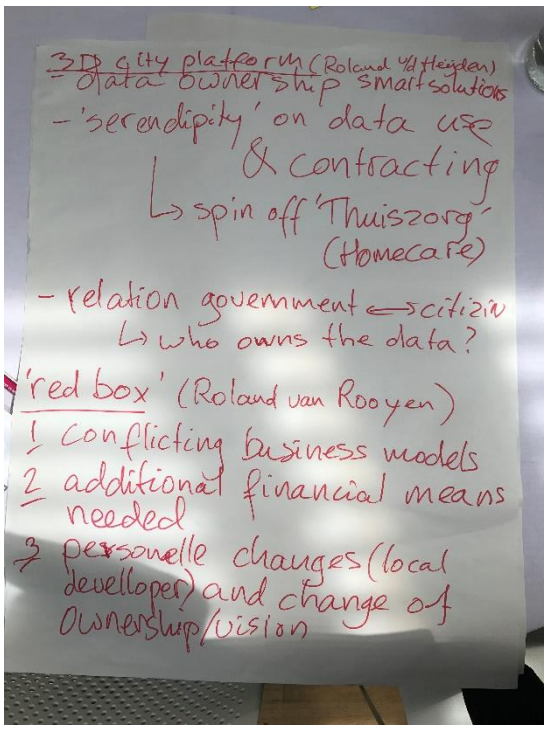
Main conclusions and similarities
There are several similarities between the unanticipated / unexpected events showing up in the Lighthouse and Fellow cities:

- Political changes due to local and national elections. This is both perceived as a risk as well as that it creates opportunities to pro-actively influence the sustainability agenda of the city.
- How to deal with project boundaries (physical, stakeholders, regulatory, time schedules) in order to optimise business cases, optimise sustainability performance and grasp the opportunities to connect to other projects and initiatives in the area.

Rotterdam

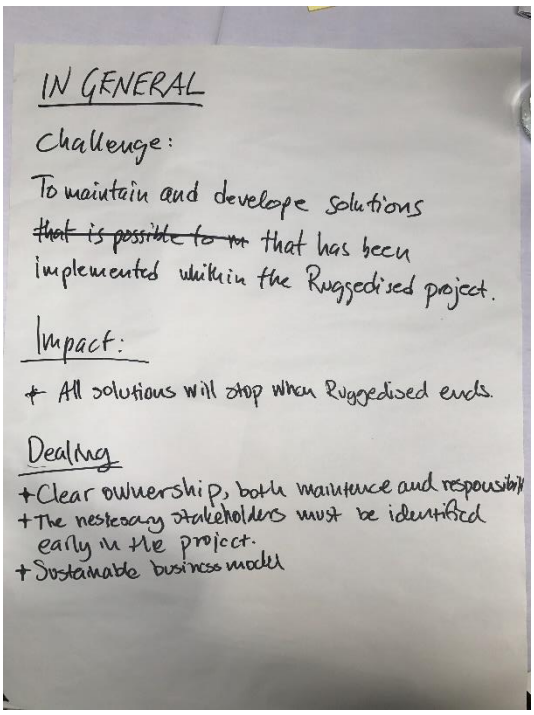
- 3D city platform. Challenge is to get the details of data ownership.

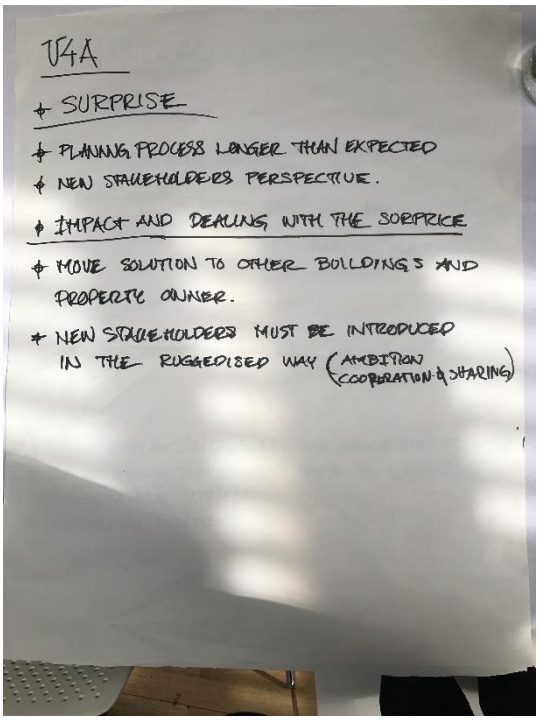
- Business model and lay-out of the smart thermal grid. A new stakeholder came into play Heijmans.



Umea

- Challenge with the apartment buildings. Planning process took a bit longer. Introducing a new stakeholder in the process. This is an opportunity to make people more aware of the fact that smart cities is about sharing.

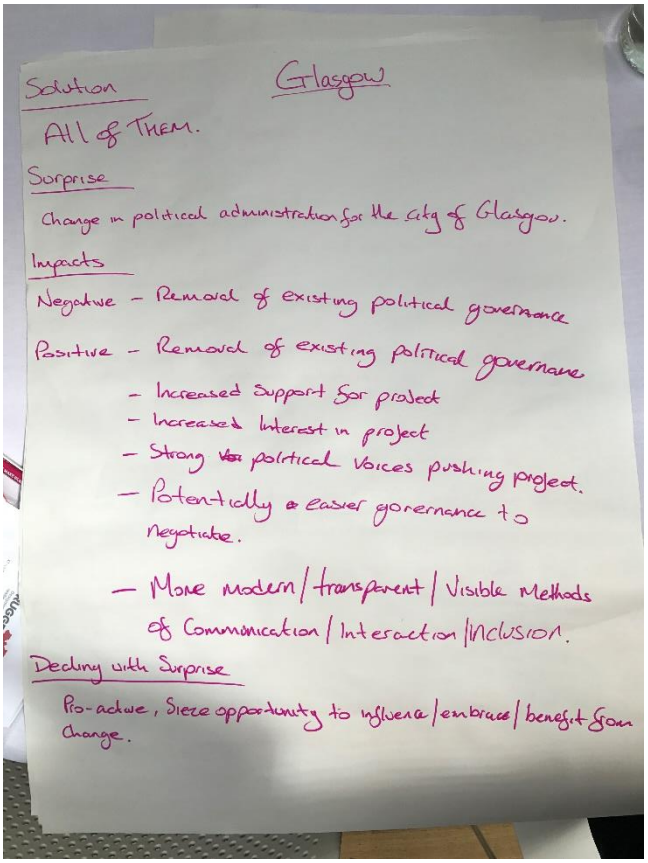


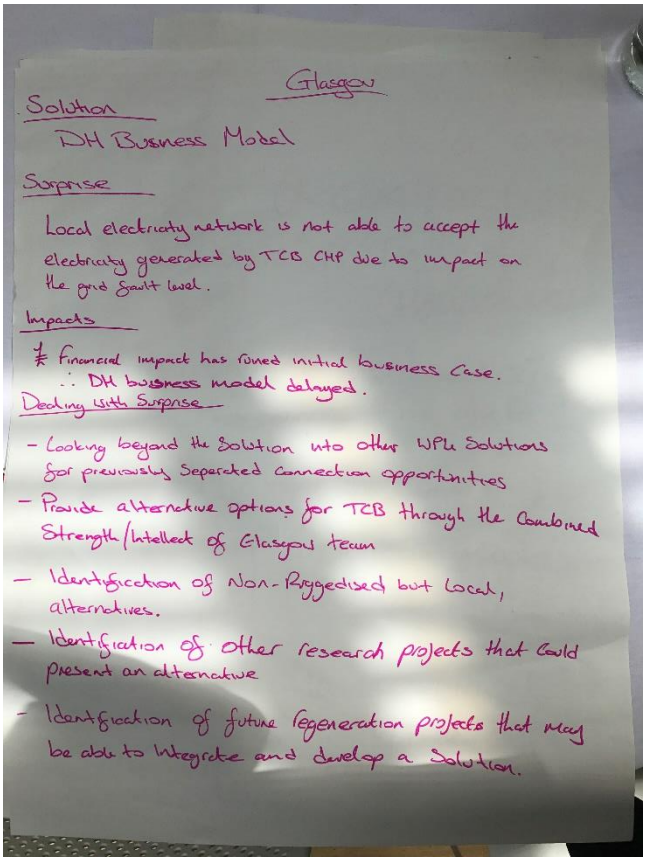


Glasgow

- District heating business model under pressure. Urged towards extending the boundaries of the specific solutions and connect solutions to build up the business model again.

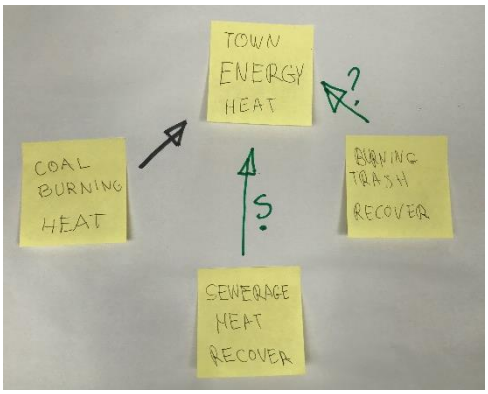
- Other local projects that might be able to connect to the grids.
- Changes in political administration. Both a risk and an opportunity. It makes you pro-active and leads to changing agendas.





Fellow cities

- Political events – local/municipal elections
- Other projects at the municipal level to integrate with RUGGEDISED
- Industrial associations and other institutional organisations are highly interested in RUGGEDISED, so there are unexpected opportunities to capture.
- Additional heat suppliers to the grid. How can we develop an organisational structure to avoid the monopolistic supply by the current private party and feed into the grid with multiple sources. Highly regulated market.



Follow up

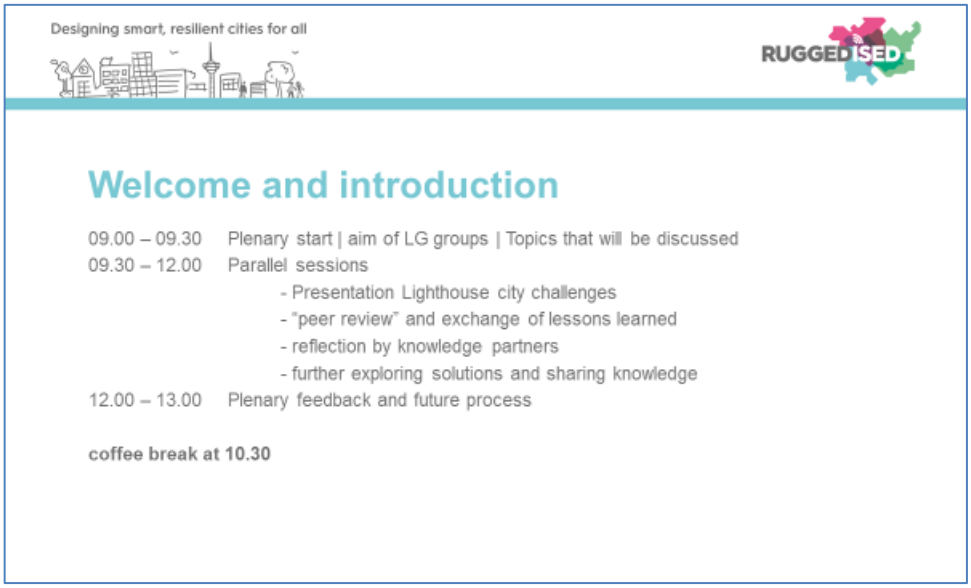
TNO and AIT will further elaborate on the challenges by conducting short (phone) interviews with contact

persons. We will develop ‘stories’ and ‘narratives’ around the issues raised in this session and will address them in the Liaison Group setting. We will collaboratively search for ways to improve ‘awareness’ and ‘sensitivity’ to better Expect the Unexpected.

For further information please contact Adriaan Slob & Alexander Woestenburg
Adriaan.slob@tno.nl & alexander.woestenburg@tno.nl

Appendix 3 - Minutes of the 2nd Liaison Group meeting in Glasgow (15 June 2017)

1. Program



2. Hardware group

Participants: Roland van Rooyen (ROT), Ciaran Higgins (GCC), Piotr Grzelak (GDANSK), Laura McCaig (TS), Ghazal Etminan (AIT), Mark Bolech (TNO), Alexander Woestenburg (TNO)

Presentation by Roland van Rooyen

Rotterdam - The area concession contract Hart van Zuid
Before zooming into the Smart thermal grid it is good to know where the existing contract of the area originates from. The area (re)development Hart van Zuid has a special history: it started 15 years ago as a real city development and resulted in a struggle within the city department with the wish-list based on the various city programs on Sustainability, CO2 reduction, Social impact, Mobility issues, Economical impact etc. The city was unable to come up with a concrete plan which met all wishes. This was the start of a dialogue with the market which resulted in a unique tender and unprecedented in the Netherlands. The tender was an area concession for 20 years for (re)development of buildings and public space with a fixed budget and a fixed program and an optional program which was judged on quality. This resulted in a signed Public Private Partnership contract in 2013 with one market party for 330 million euro's with a lot of freedom as long as requirements were met.
The (re)development consists of:
1. Demolition of the existing swimming pool and transformation of an existing office into a new swimming pool
2. Building of a theatre and library in one building on the old location of the swimming pool
3. Building of an international congress center
4. Renovation of the existing exhibition center Ahoy
5. Renovation of shopping mall and enlarging it
6. Building of 100 houses

7. Renovation of the existing bus-station and roads, new space for small enterprises
8. Transformation of Gooilandsingel into pedestrian area
9. Renovation of public space around Zuidplein/Ahoy

Although one of the energy goals of the contract was to build with a 50% better energy performance (EPBD) than the legislation in 2006 stated, this didn't result at the end in additional value: the goal was simply already met because of the autonomous change in legislation for the building permit in the 10 years between program of requirements and building permit procedure.
This created the urgency to come up with sustainable added value, the sustainable plus, and the Smart Cities Call-1 seemed the ultimate chance to get this added value to the existing contract. Although the financial consequence of RUGGEDISED is relatively small (1,4 million vs 330 million), the sustainability result is big due to financial leverage and better business case situation for e.g. solar energy. This extra sustainability is also a must have for the new Sustainability Program of Rotterdam.

Also this RUGGEDISED project is the first case of the Roadmap Next Economy, a program of the metropolitan region Rotterdam-the Hague led by Jeremy Rifkin. Goal of this program is to make the Rotterdam region economic viable and resilient for the coming decades through sub programs on smart digital data, smart energy, circular economy, entrepreneurial region and next society.

The Smart Thermal Grid (STG)
Smart solutions 1-4 are part of the STG and consist of a thermal heat and cooling exchange grid, seasonal storage, energy from waste water, energy exchange with surface water and a pavement heat-cold collector. This low temperature exchange grid/STG is connected to the existing infrastructure of the area and the buildings that remain. The existing shopping mall and exhibition center Ahoy have already a connection to the city district heating grid. The new buildings and existing exhibition center Ahoy will be connected to both the district heating grid as to the STG. This integral approach using existing infrastructure and energy components makes the STG complex. The individual components are not unique themselves, but putting them together with one area energy-management system makes the STG unique.

But having to use this existing infrastructure and components caused dependencies which influenced the design of the STG both financially as from a sustainability point of view. At the same time the existing buildings have a heat delivery contract with energy company Eneco, whereas the new buildings have to connect to energy company Nuon. This makes things complex and drives up the price, even more since Nuon has no heating grid in the area and thus has to deliver heat through the infrastructure of Eneco. Eneco will build and do the exploitation of the STG.

Another issue is the CO2 performance of the reference situation (district heating grid). Since the heat delivered to the district heating grid is regarded as almost CO2 free (92% waste energy), the CO2 reference situation is very good. This resulted in a negative CO2 reduction with the STG. All CO2 is addressed to the process of heat incineration, and only the reduction on electricity generation (8%) is addressed as CO2 to the district heating grid. This seems unfair, since half of the waste has a fossil origin and the delivery of heat should be seen as a primary product, not as waste, since a normal market price is paid for this heat. This gave the strange result that doing nothing (district heating and compression chillers) would result in a better CO2 performance than the STG with seasonal storage and heat pumps. We would like to suggest to add an extra KPI on sustainability next to the CO2 effect, especially for thermal smart grids. This sustainability index should in our opinion take into account the total lifecycle (well to wheel analysis) including transport related CO2, exergy losses and air quality. This to make a more fair comparison between waste-incineration based district heating and other heating systems. A financial effect on the design of the

STG comes from the tariff system for district heating. A certain amount of heat has to be used per year to avoid very high energy prices.

The above mentioned effects resulted in a design based on avoiding peak load tariffs of the district heating and using the seasonal storage capacity that is already in use. This results in 75-80% use of heat from the district heating grid and 20-25% from waste streams and buildings through seasonal storage and heat pumps. This effect makes the STG backbone for exchanging (some) energy between the buildings relatively expensive.

There is also a political context since the city of Rotterdam is a big shareholder of parties wi*thin the district heating grid.* It is good to acknowledge that the STG design in Rotterdam is influenced by the existing situation and regulation/contracts. This will always be the case in Smart Cities projects and it's good to optimize the system within these boundaries. TNO and other advisory bureaus have looked at the design of the STG as it is now. To check if there are obvious reasons why the business case ends negative. Outcome is that no mistakes are made, but that further optimization further on in the design process good improve the business case. Most important advise was to look for redundancies in the design and to broaden the scope for exhibition center Ahoy and take into account their high temperature building related heating system and to change this to a lower temperature. The STG could then supply more heat there.
An organizational aspect is also that the contract party of the area is primary responsible for the STG, but that energy company Eneco is supposed to build the STG and do the exploitation. This causes situations where the budget holder has to do the feasibility studies and make financial calculations, but the energy company has to be OK with the outcome of it. This makes it hard to have a business case which is reliable and supported by the energy company also.

Relation STG to other smart solutions
The STG stands not on its own. Idea is to compensate the lack of committed CO2 reduction with extra solar energy on the big roofs in the Hart van Zuid area. We already committed ourselves to 12.000 m2 solar panels, but the compensation from the STG will add 5.000-7.500 m2 on top of this. This looks promising, since the proposition to building users look good and that the inventory of suitable roof-area could be sufficient. Data-management of the energy-system should result in an energy management system on area level. Ultimate goal is that this system can influence the individual building energy management systems and optimize on area level. Privacy issues arising from sharing data are evident.

Discussion

Project boundaries
Ciaran describes the Glasgow experiences with district heating. There is no city-scale district heating system like in Rotterdam. Local Collective District Heating system is based on heating with natural gas. Only the big institute buildings are a real option for installing district heating. These buildings are the quick wins. The problem that pops up each and every time: who is going to pay for it? Public Private Partnerships for building schools. These are hardly interested in lowering the heating demand. A demonstrator project like the one with Strathclyde University can help building a business case. On top of that, new relationships grow during the project. Those can become the core of a consortium for new / larger initiatives. For successful smart city projects it is crucial to think about the boundaries of the project and how pilots can expand during their lifetime. This adaptivity and flexible upscaling potential is often perceived as potential risk, but actually increases the chances of successful connections.

Increase insight

There is a constant tension between Scottish energy and the city of Glasgow. In fact there is a kind of Scottish regulated monopoly for the two distribution companies Scottish Power and SSE. There is need for a collaborative project approach, in which information will be shared. That way the dependencies and stakes can be understood more clearly.
This quest for more insight in stakes, interests and incentives is shared by Rotterdam in the STG case. What are the buttons to press on? What can the municipality do to influence the value chain of heat energy and not only focus on the infrastructure in a particular area. Get an holistic, long term overview of the energy landscape. Some partners are driven by lawyers and accountants that have a very short term, risk avers view on the issues at stake.

Demonstrator projects
Rotterdam presents several alternative scenarios to increase the bankability of the STG. The idea was to provide evidence for efficiency gains in a fourth generation heating system. With the original goals perhaps not being met, downscaling the system might be a solution. Leaving out the “back bone” of the planned system might be an answer. The stakeholders should go ‘back to school’ to redesign and do their homework. If Rotterdam is adjusting the STG design it is important to reconsider what they would like to prove or demonstrate. Is it really a compromise that is proposed now? How can Rotterdam redesign the STG to make it interesting for replication and adjustable in the future? What are the different interests involved considering it is just a pilot at this moment?

Consortium building and trust
Gdansk’s experiences show poor interlinkages between the various levels of administration and other stakeholders in Gdansk. Therefore it is very hard to establish a smart cooperation. Rotterdam their experiences indeed show that partnerships are highly dependent on trusting each other. What preconditions should be met to actually work together? How do you build trust within a consortium and between partners that have different stakes?

Final discussion point regards whether this meeting and the type of information that was exchanged was useful: yes. Very informative, also opportunity to learn from each other and get inspired as well. The group should find some form /modus for regular interaction between the cities (lighthouses as well as followers). Group discussions were appreciated. Some basis for sharing knowledge and inspiration should be defined.

3. Software group

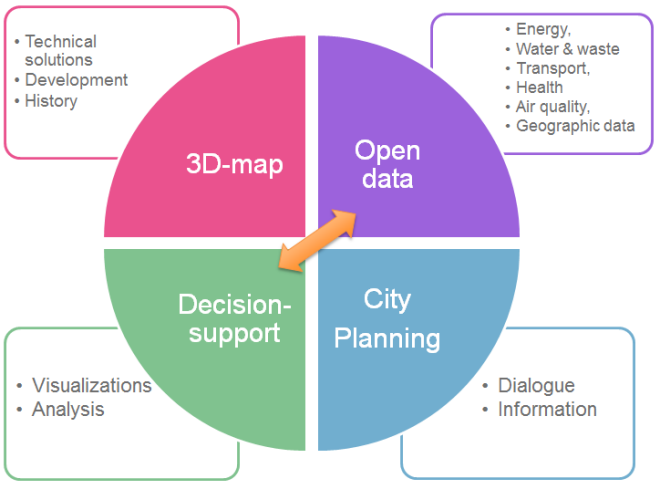
Participants: Ebba Sundstrom (UMEA), Roland van der Heijden (ROT), Rick Klooster (FI), Christine Downies (GCC), Joe Clarke (US), Jiri Drinovsky (UB), Mateusz Bonecki (PINTEC), Hans-Martin Neuman (AIT), Bas Kotterink (TNO)

KEY FINDINGS

- *Combine* Top down visions & bottom-up action.
- *Share* the visions/dreamscapes and see where the different cities focus their action and find synergies lessons.
- *Develop Micro-services*, *build one or two for the next GA* and use them to test/build/populate the information model.
- *Process*: Going forward we will work both on the high level picture/vision/dreamscape and concrete micro-services. For the next L-group meeting we aim to have a concrete service to showcase. We should probably have a meeting in October to take stock and prepare for the next GA.

Presentation Umea Vision on Information Portal by Ebba Sundstrom

In earlier discussions the group agreed to start sharing the *Information System Visions* of the RUGGEDISED Cities. Even if in different stages of maturity, discussing the different information strategies promotes learning across the cities. In Glasgow Umea was presented their 'dreamscape' of a Smart City Information portal to the other LG members. The presentation is available here The Umea portal is organised in four dimensions:



Discussion

The first round of comments focused on *top-down versus bottom-up*. It was suggested that people 'from the other side' (clients, end-users) be included in the story from the beginning. Instead of only working top-down *consider working bottom-up*. Start with the data, what is the data like? Then on the basis of that you can build your system as a virtual world, as a model. Make sure to *include examples* about the real world. Not only big aspirations. *Be specific* by working on actual *prototype services*. Dream big, but start small and address a concrete problem.

Example services could be applications using the GPS of buses, or applications for parking problems using secure cameras and anonymization. But where do you get help on the limitations? In building a 3D map

with GPS there are lots of detailed questions.

On *trying things out*, the issue of early user involvement was discussed. Umea gave the example of wind energy projects. People want clean energy but not in their backyard! Try-outs are needed to optimize placing and to get people on board. One way of trying things out is to build models. Of course communication and due process is a key factor: get that right first. When engaging on models, use simple tooling.

On *sustainability*, make sure the system survives after the end of the project. Data access is a real issue here. There are many rights limitations and there is often a reluctance to share. The answer is to *get data-providers involved early* for example by organising big workshops in which to address their needs and contributions. *In Umea* all data streams are intended to be public but there are real issues on who actually 'owns' the data.

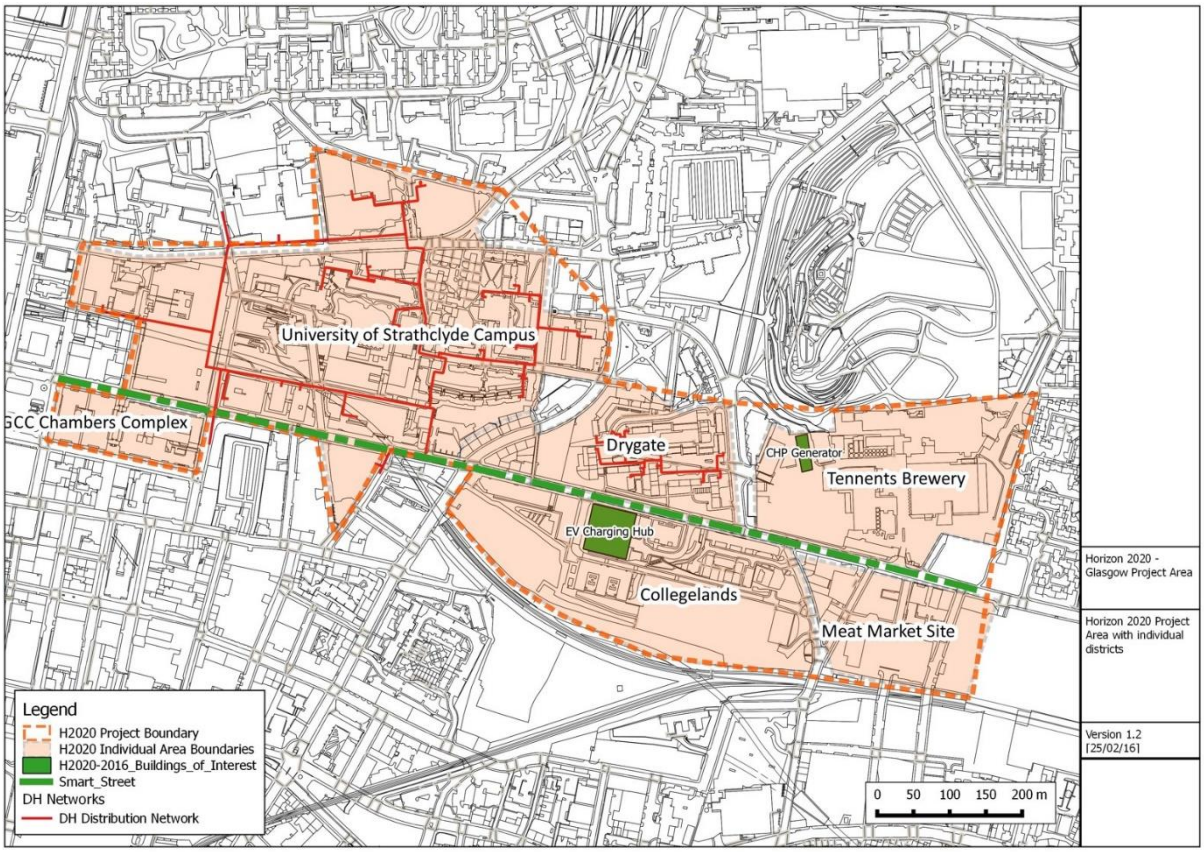
Another import topic was how to deal with *legacy systems* that have set policies and capabilities. Make sure that end-user systems will not kill the system by using a middleware layer. Shield the legacy systems. Build a safe system on top of them. ITS for example is 10 years old now, how will we work around it? In the experience many systems are in fact isolated (hospitals etc) making it difficult to get them to work together or to work across them.

The final discussion was on micro-services. In RUGGEDISED we are deploying some innovative energy solutions. Every one of them has specific data sources and calculations and services that are for example alerts, alarms or predictions. We can stay close to the actual solutions by building 'Atomised e-services' with real-time data. These services and the data could be offered to citizens through apps. To test out how this works we could build one or two services to test the big picture. In Gdansk they work on a bunch of *generic e-services* that have event-driven *'micro' services* on top. For the next ICT Liaison in The Hague meeting we aim to select one or two micro-services to Demo and to discuss how they sit in the overall Information services framework.

4. Orgware group

Participants: Gavin Slater (GCC), Andre Houtepen (ROT), Jörgen Sandstrom (UU), Sara Baiocco (ISIVVOVA), Klaus Kubeczko (AIT), Marcel Oosterhout (EUR), Claus Popp Larsen (RISE), Adriaan Slob (TNO)

Presentation of the case in Glasgow by Gavin Slater
Gavin explains with maps the case of the smart heat network in Glasgow and its wider context. The heat network should meet requirements from social aspects / poverty alleviation (affordable, transparent prices), security and CO_2 reduction. There are several smaller spots in the city with district heat that are not connected. With the heat grid of the University that is now developing, the question is how to extend it in such a way that it can meet the requirements and has the potential to ultimately connect with the other spots. What types of strategies should be developed and what are business or governance models (PPS, a separate company, ownership by the municipality, direct contractual relationships?) that can support this strategy?



Discussion

The other Lighthouse cities are asked to exchange their experiences on this issue first and then the experts are asked to give input on these questions.

Umea

Umea experiences similar issues to those in Glasgow. For the heat grid in the Lighthouse district of Umea they are looking to create a company, which is either a PPS or owned by the municipality. A PhD-student is working on the strategic options for this. Umea will put Glasgow in touch with the PhD from RI:SE. This even could lead to a broader topic for the PhD-student: not only the Umea case but also the Glasgow case, which is interesting because of the different institutional, political and regulatory contexts. Umea owns the generation assets and distribution network in other areas of the city. Umea is happy to share the relevant information with Glasgow through documents or phone calls.

Rotterdam

There is a heat grid in Rotterdam that uses the largely residual heat from a waste incinerator in combination with the gas fired electricity generating plant (STEG)(see also slide no 1 in Annex 1) and from 2018 on the residual heat from refinery Shell Pernis. Initially the network in Rotterdam was owned by the city, then the infrastructure was privatised and owned by a company in which Eneco (an energy provider) and the city are participating. The city is majority shareholder and can influence decisions. There are plans to extend this heat grid further to the South-West part of the Province, an area where many greenhouses (that demand heat) are located.

Heart of south (the Lighthouse district) wants to develop a smaller network for exchanging heat among the buildings that is not connected (yet) to the bigger network. It is hard to create a business case that is

profitable because the bigger grid is protected by different types of regulations. The business case shows that the bigger grid will lose revenue due to lowered demand in HoS and it can then increase prices to mitigate losses – due to monopoly, this is very bad. Therefore, Rotterdam is now looking at a stepwise approach to first start with only buildings that can exchange heat in a profitable way (also outside of the Lighthouse district), and then extend this in future further, with a possible option to connect it to the bigger heat grid (but then some of the rules need to be changed).

This is very interesting for Glasgow as it could be a developing issue in the future in Glasgow. This provides valuable insight on how competition from other District Heat operators could develop without municipal influence/control. Rotterdam is happy to share the relevant information with Glasgow.

Vienna
Klaus Kubeczko exchanges some experiences in Austria/ Vienna. In Vienna – as everywhere in European large municipalities - the city owned energy utility had to be unbundled: organisational units with profit orientation has to be separated from infrastructures which are of monopolistic nature. Under a city owned holding company, this was done separately for different energy carriers (electricity, gas, district heating). Reorganisation in 2013 lead to the merger of all monopolistic network infrastructure parts (electricity-grid, gas-grid, district heating grid and telecommunication grid) into the ownership of one organization (Wiener Netze) under the control of the holding company (Wiener Stadtwerke).In general Klaus raises the issue that a development plan for district heating based on smaller heat networks built step by step, which can be flexibly connected to other smaller networks through heat exchangers, might be a more robust strategy for the future.
Gavin Slater, is very happy with this exchange of information, as it gives a good insight in the similarity of problems in the other cities.

Input from the experts

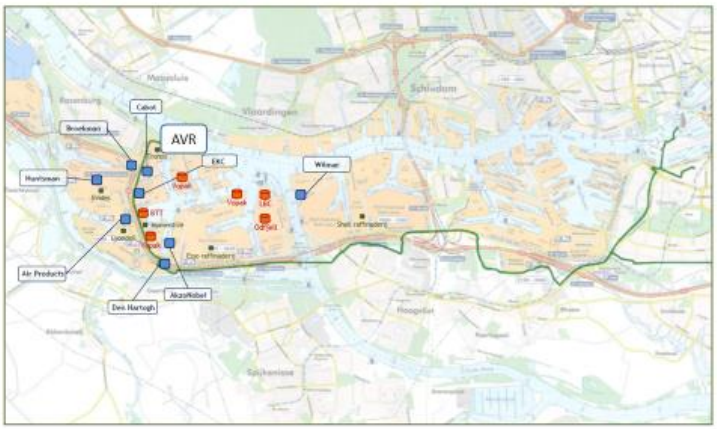
Marcel Oosterhout, Erasmus University Rotterdam
Marcel can put a masters student into looking at business models also for Glasgow. He shares a scientific article (Antonio Pantaleo et al., ESCO business models for biomass heating and CHP, in Renewable and Sustainable Energy Reviews 30 (2014) pp237–253) and shows the slides that are in Annex 1.

Claus Popp Larsen, RISE
Claus presents the similarity with the strategic issues on how to organise communication networks and ownerships. The vertically integrated operator model is also suitable for District Heat, where Network Operator (NO), Communication Operator (CO), and Service Provider (SP) work separately or in an integrated system. In communications analogy, in Sweden, the municipality owns the fibre network and operators compete to get a concession for a 5 year period to operate. Critical infrastructure should be owned by the municipality or some kind of public entity.

Annex 1: Slides of Marcel Oosterhout:

Business models for district heating – best practices

- Heat exchange Rotterdam (from port (waste/heat of industry and refineries) to city, linking to city heat networks of energy companies Eneco and Nuon)
- Heatcompany Infrastructure and heatcompany Exploitation



Business models for district heating – best practices

- Longer term perspective

Framework for ESCO Business models

A. Pantaleo et al. / Renewable and Sustainable Energy Reviews 30 (2014) 237–253

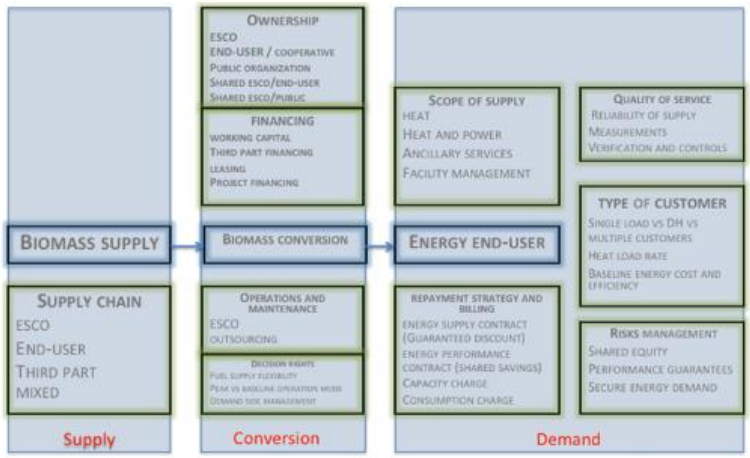


Fig. 1. Flowchart of biomass-ESCO operation stages reporting typologies of business models and contractual relationships.

Business models for district heating

- Develop **revenue-generating (or cost-cutting) initiatives**: Revenue-generating and cost-cutting initiatives, such as fee and tax collection or electronic government procurement, can become self-funding and prove appealing both for budgetary and political reasons
- Forming revenue-sharing agreements and brokering public-private partnerships**:** Partnerships with a vendor, service provider, systems integrator, or even real estate developer on a revenue-sharing basis can defray upfront costs and risks of a new initiative
- **Enabling larger city IT departments to become service providers (towards other cities):** Excess capacity from large municipal IT infrastructure or applications deployments can be provided to neighbouring cities or organizations, with the larger city IT department acting as a service provider or through a managed service provider
- **Facilitating multicity initiatives, using economies of scale:** Upfront agreements to pool resources and share infrastructure facilitate the launch of large IT initiatives
- **Enabling data monetization:** The use of primary data generated by instrumented infrastructure provides a potential revenue source for data owners

More traditional business models in smart city contexts:

- **Leasing and financing**: provides flexibility in case of budget shortfall or other political contingencies
- **Barter or in-kind exchange**: Exchange of product testing or customer references for new technologies is a way of overcoming budget shortfalls, particularly for universities or research facilities with skilled developers and users

Annex 2: slides of Claus Popp Larsen

BUSINESS MODELS FOR DATA

- SAME PRINCIPLES AS IN THE SHARING ECONOMY

"IoT " today IoT how it should be

Open platform – or "almost" open?

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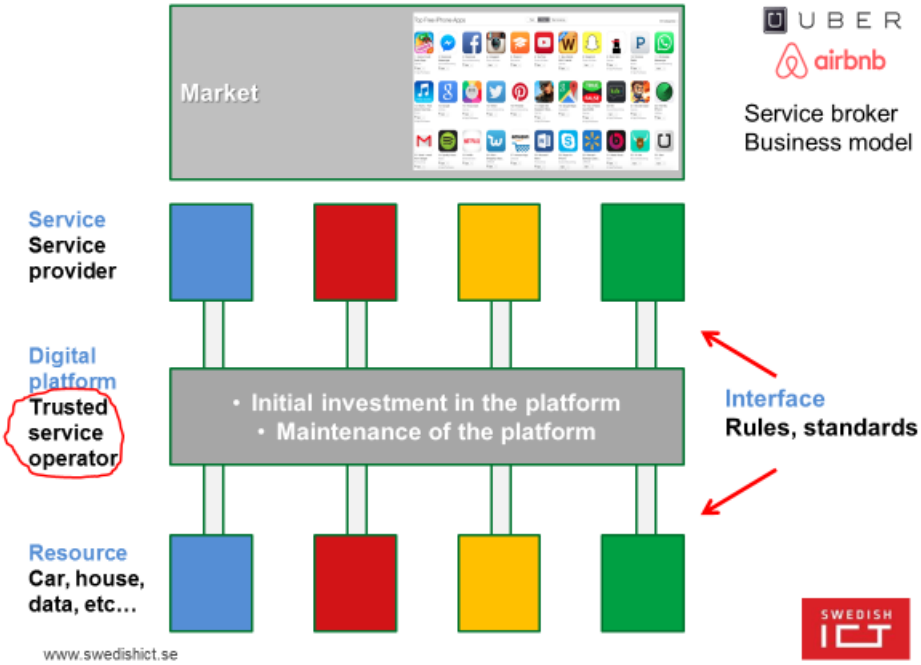

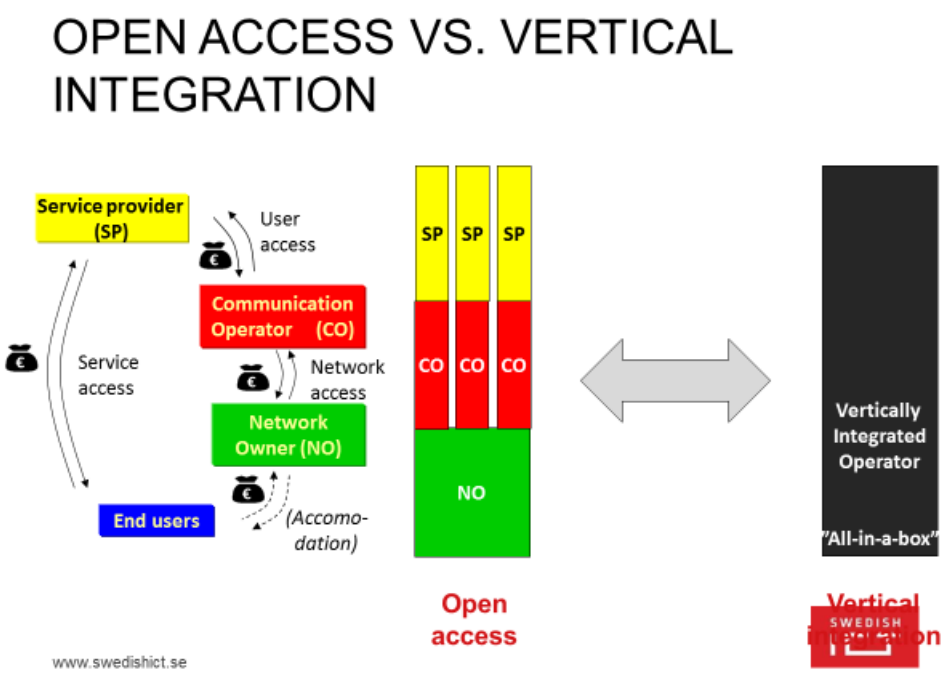
OPEN ACCESS VS. VERTICAL INTEGRATION
Service provider (SP)
User access
Communication Operator (CO)
Service access
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End users
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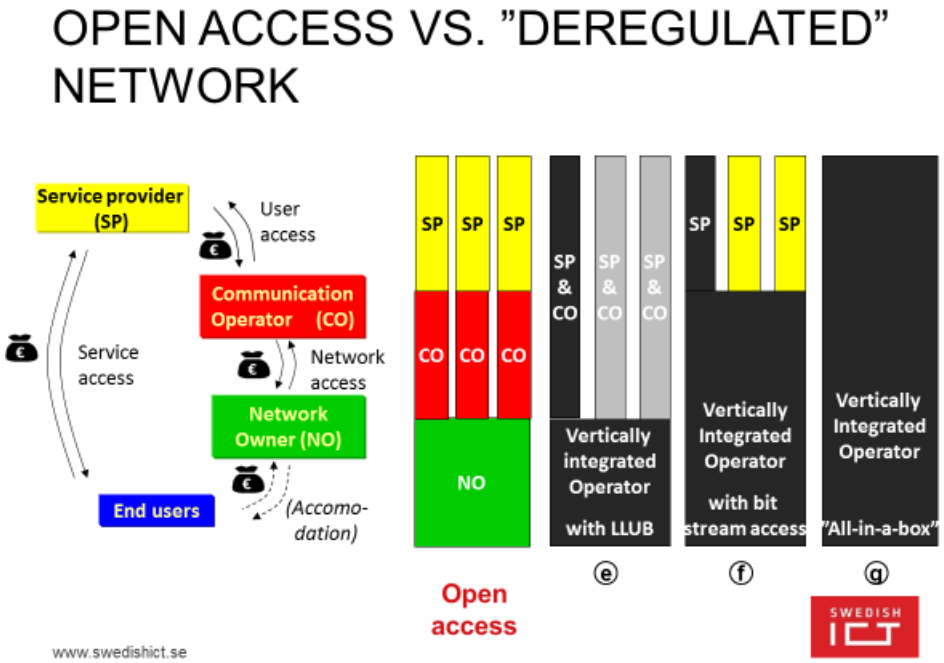
OPEN ACCESS VS. "DEREGULATED" NETWORK
Service provider (SP)
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Communication Operator (CO)
Service access
Network access
Network Owner (NO)
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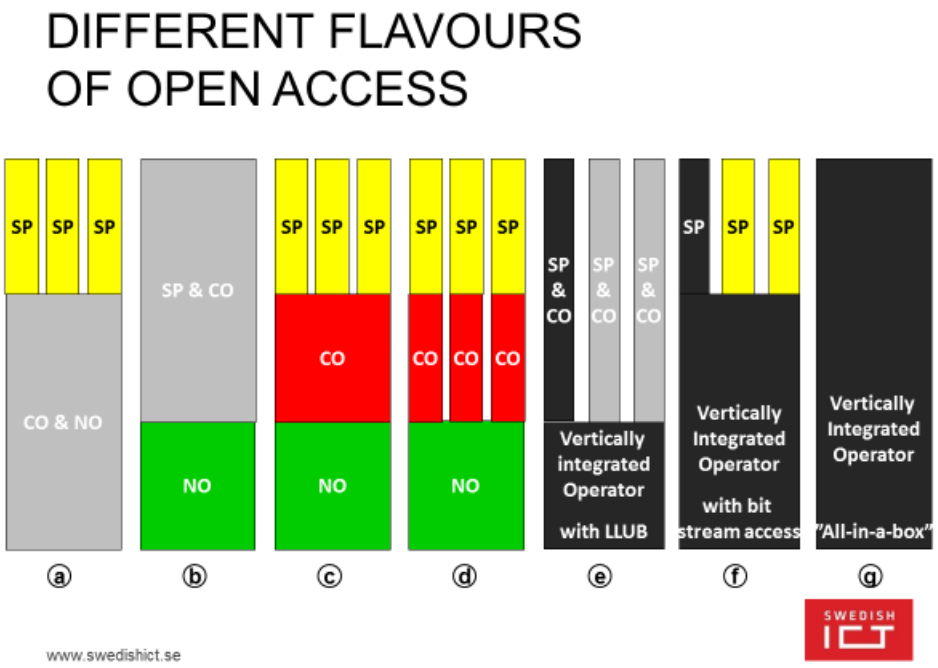
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Appendix 5 - Minutes of the 3rd Liaison Group meeting in Amsterdam (8 November 2017)

Program

Welcome and introduction

9.00 – 10.00 Plenary start - *Stories on smart city development – District Heating*

*** Coffee break***

10.15 – 12.00 Liaison Group session 1
- *Hardware & Orgware: District Heating systems, organisation and incentive structures*
- *Software: Further prepare and share the dreamscapes*

*** Lunch ***

13.00 – 14.00 Plenary start - *Stories on smart city development - EV* charging
14.00 – 15.30 Liaison Group session 2
- *Hardware & Orgware: EVcharging infrastructure, organisation and incentive structures*
- *Software: Develop smart city micro-(e)services, populate the information model contained in the dreamscape*

15.30 – 16.15 Plenary *Carousel*
16.15 – 16.45 Plenary discussion - *Agenda 2018*
16.45 - 17.00 Reflection by Graham Colclough (RUGGEDISED advisory board)
18.00 – Collaborative Dinner

15/01/2018 2

Stories on smart city development – District Heating

Both Rotterdam and Glasgow presented the three main challenges to successfully implement the smart district heating solutions.

Rotterdam:
Challenges presented by André Houtepen

- RUGGEDISED smart solutions add high sustainability ambitions to the existing PPP project Hearth of South. Some solutions face a financial gap in the business case, which is not entirely covered by RUGGEDISED budgets. The question is: who is going to pay for it?
- Building contractor looks at immediate/short term costs. Not/less interested in revenues in the future. This emphasises the difference in levels of ambition between the local government and the developer.
- Time schedules of building process and RUGGEDISED are not synchronized.

Maarten Kokshoorn (Heijmans) and Lambert den Dekker (DWA) have sent their perspectives on the main challenges. They stress amongst other things:

- The difficulty to integrate the smart solutions in an ongoing PPP project Heart of South, which is already in the construction phase. Adding an innovative concept to the Heart of South-project requires extra effort and time to come to the right approach, this time is limited.
- The challenge to come to a good split of responsibilities and ownership of the thermal grid

- Everyone should refrain from his own interest and focus on the same goal: make the Smart Thermal Grid work. But the existing contracts and limited budgets makes this a challenge
- Energy supply and demand should be balanced if one wants to interconnect buildings. Otherwise the added value of a Smart Thermal Grid is low. Distance between buildings should be small, otherwise it will result in large investments and long periods of return on investment. With Smart Thermal Grids short term and long term thermal heat storage are difficult to avoid.
- Putting cables in the ground in existing built areas, results in high costs and complex coordination
- Project development is, logically, focused on project management aspects such as money and time. Innovations are complicating and frustrating the process
- With existing buildings it is difficult to get information on existing installations, monitoring data and design specs

Glasgow:
Challenges presented by Gavin Slater:

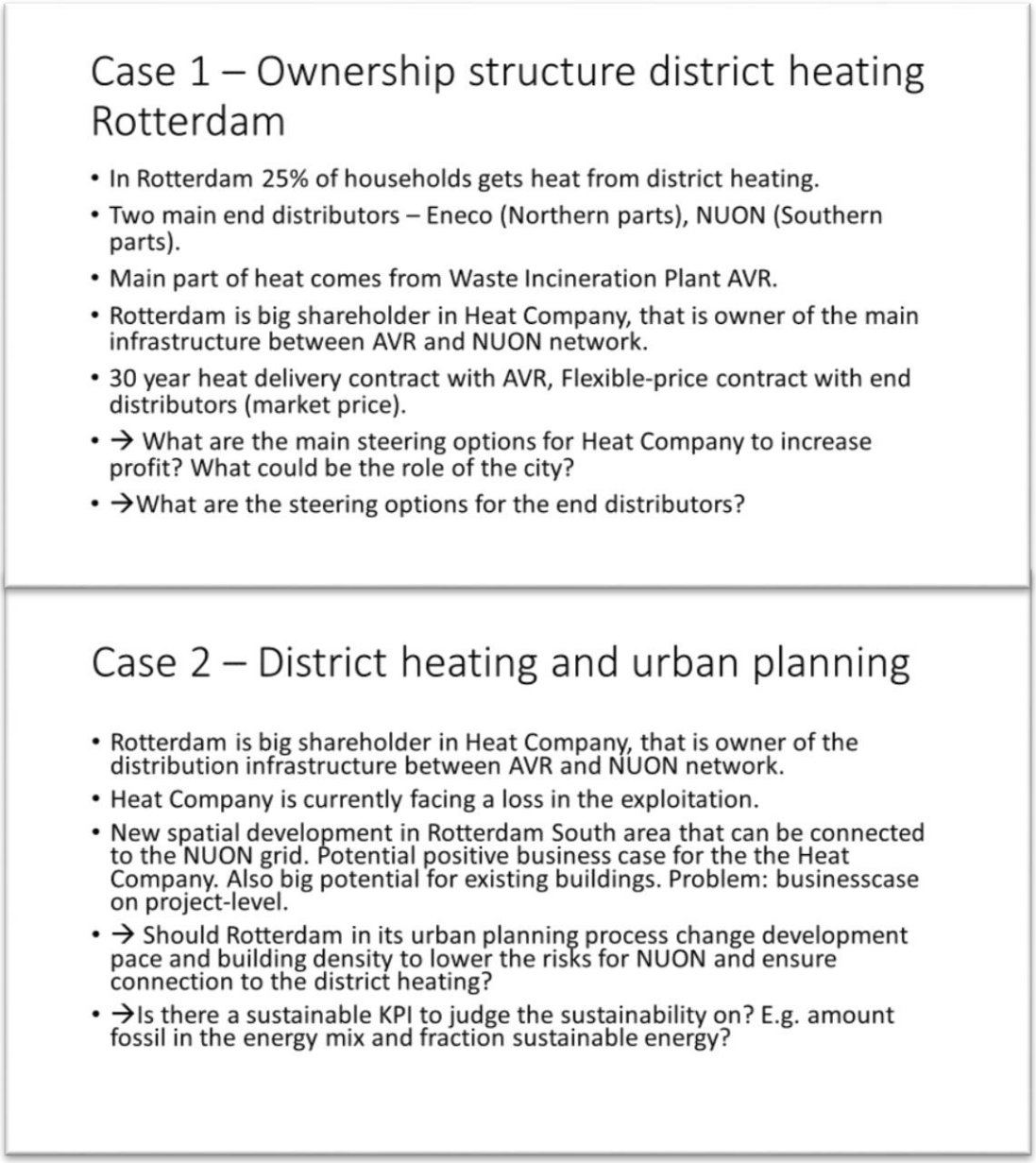
- District heating is a growing energy solution in Glasgow, yet no example has managed to grow beyond its planned boundary to connect other customers. We seek a way to develop the contractual models that will facilitate the connection of heat generators and consumers.
- Cost of district heating is high and consumer opinion is low. In addition, national rates applied to district heating networks is high. We wish to find out more about how this is managed in our lighthouse and fellow cities.
- We wish to explore municipal ownership of district heating systems but have very little expertise or experience in this area. We wish to learn from our Lighthouse and fellow cities.

By ways of a short self-interview on film Colin Read (GHA), Rody Yarr (UoS), Andy Mouat (GCC), Billy Mason (TCB) gave their perspectives on the main challenges. They stress amongst other things:

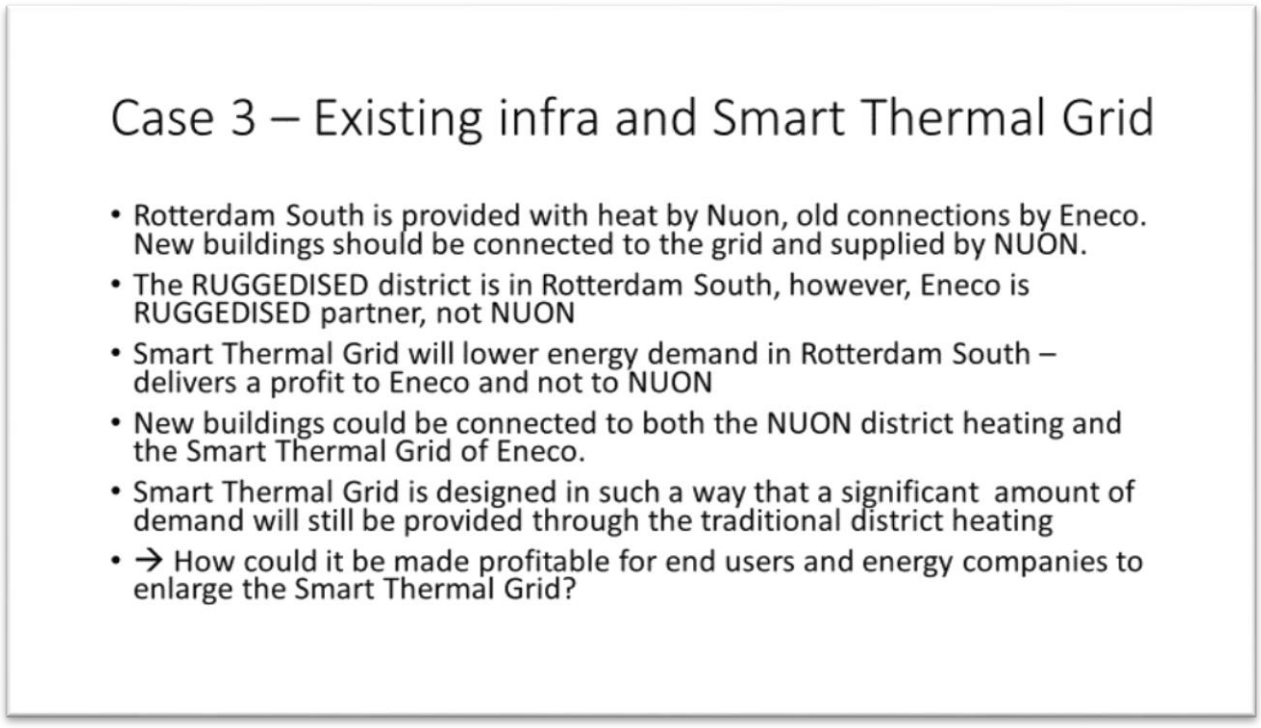
- the importance of community involvement from the start of the project, especially as it regards mixed ownership of the buildings
- Getting the right skills in the project team
- Implementing district heating for existing buildings, during the retrofitting process. Retrofitting in a densely built and highly serviced area. So challenge is to actually get the pipes into the ground.
- Making sure the waste heat from industrial processes is provided at an affordable rate
- To make district heating a statutory requirement to connect to instead of private heating options
- That there is a need for connectedness, collaborative learning, joined-up thinking and sharing experiences.
- The prospect of change is a challenge. Dealing with an industry and with customers who are used to a specific heat system. Are individuals willing to change their heating systems?
- Engagement and sharing of data.
- Strong alignment of objectives of different partners
- Significant amount of investments to create stability in the energy network before the industry is willing to connect to the network.

Hardware & Orgware group on disrict heating

The discussion started with a presentation by Roland van Rooyen on the Rotterdam Hart van Zuid Smart Thermal Grid challenges and the overall governance of the district heating system in Rotterdam. Roland presented three dilemmas: regarding the general ownership structure of the district heating in Rotterdam, regarding the cross-overs between energy and spatial planning, and regarding the tension between existing infrastructure and additional



infrastructure.



In Rotterdam a great deal of the city is connected to the district heating, fed-in from a waste incineration plant in the Port of Rotterdam. Within the RUGGEDISED project in the Hearth of South area a Smart Thermal Grid (STG) (exchange of heat and cold between several buildings including Aquifer thermal energy storage and sustainable energy supply from pavement, water and sewage) is developed. The STG is competing with the district heating system, in financial terms and CO2 reduction perspective. First, the more efficient and effective the STG can provide the buildings with heat, the less these buildings rely on the district heating network. Second, from a circular economy and broader sustainability perspective, in practice the STG is more sustainable (re-use and reduce) than the district heating network (energy recovery from waste incineration). However, on paper the sustainability performance of the district heating is already very high due to the used calculation methodology for CO2 emissions:

- Optimizing the STG in the Heart of South district decreases heat demand in the area and, thus, from the district heating network. The lower the demand, the higher the price that the energy company NUON is going to charge (peak tariffs). Actually these alternative costs are now putting the business case of the STG under pressure. Moreover, in the technical design several design criteria were taken into account. One of the major criteria or requirements was to avoid the high tariffs. This means that the existing district heating infrastructure governance in Rotterdam placed the boundary conditions for the design. It has had a significant influence on the size and optimization of the STG. Here it does not help that the city of Rotterdam is shareholder in the Heat Company that owns a part of the existing district heating infrastructure. Best solution for RUGGEDISED area would have been to connect to the district heating system for only the peak heat-demand, so extracting only a small amount of energy/year and try to optimize the heat & cooling supply and demand in the area with a highly innovative STG. The example from Umea shows that a more cooperative system compared to the monopoly kind of situation in Rotterdam can be useful. Democratization of energy is actually what we are talking about. The monopoly is very much counterproductive.
- Due to the above mentioned business case related challenges the argument is made that the STG development is still to be preferred from a sustainability point of view. However, this argument reveals a major discussion on calculation methods and how CO2 reduction is appointed to different measures and systems. In theory the STG is a very sustainable solution in terms of CO2 performance. From a circularity perspective the reuse of heat and cold inside the RUGGEDISED area is to be preferred compared to the district heating network that is based on the recovery of energy from waste incineration. However, due to the calculation methodology used in Rotterdam the existing district heating system in Rotterdam, using this waste incineration heat, already performs well in terms of CO2 reduction and overall sustainability perspective. CO2 emissions of the waste incineration plant are

currently assigned to the incineration process and not to the district heating system. Only the few percent loss in electricity production by using the heat of the plant is taken into account, but not the CO2 related to the waste process, e.g. the burning of fossil based waste (around 50%), transportation, and etcetera. The sustainability gains of adding a highly innovative Smart Thermal Grid in the city are low according to the current calculation methodology, based only on CO2, which fades away one of the key drivers behind the implementation of the Smart Thermal Grid (sustainability). This situation reveals a very relevant but technical discussion regarding Life Cycle Analyses (LCAs) and the system boundaries that need to be taken into account. Central point in this discussion is whether the energy production of the plant can be seen as part of the primary process and not only as pure waste. A quite objective way to judge upon this, could be to economically allocate the CO2 to both the waste incineration and to the energy production. Apart of CO2 it would be better to have a more integral KPI for sustainability, taken into account all relevant environmental aspects, e.g. local air quality (burning and transport related) and material reuse. The CO2 performance of waste incineration itself also depends on the alternative treatment that is chosen (landfill on the one hand and material recovery on the other hand). Of which landfill is forbidden in the Netherlands.

Vested interests, in terms of an existing waste incineration plant and existing district heating network are contra-productive towards implementing innovative smart solutions. Innovations challenge existing business models and calculation methods. These challenges need to be addressed.

The discussion leads to the question what the Rotterdam Smart Thermal Grid case should essentially be aiming at. Due to the governance challenges the main actors are now taking very pragmatic design decisions that are not going into the direction of a highly innovative Sustainable Smart Thermal Grid. There is a significant influence of regulation/legislation/incentive structures that solidifies the old system.
Together we draw the following conclusions:

- Rotterdam should try to push the idea of Hart van Zuid as an experimental area allowing developing new incentives and regulation.
- It should be made clear that every decision should serve the aim of improving overall sustainability, towards a low carbon, efficient heating system on the long term.
- The aim of the pilot should be to prove its innovative capacity:
    - Come up with cooperative business cases: sharing risks and rewarding cooperation
    - Heat system based on small, local bidirectional connections.
    - Adaptivity of heat sources to keep the infrastructures local and future proof (not too costly).
- The pros and cons of the cooperative system in Umea should be worked out more to learn from it.

Software group on micro services

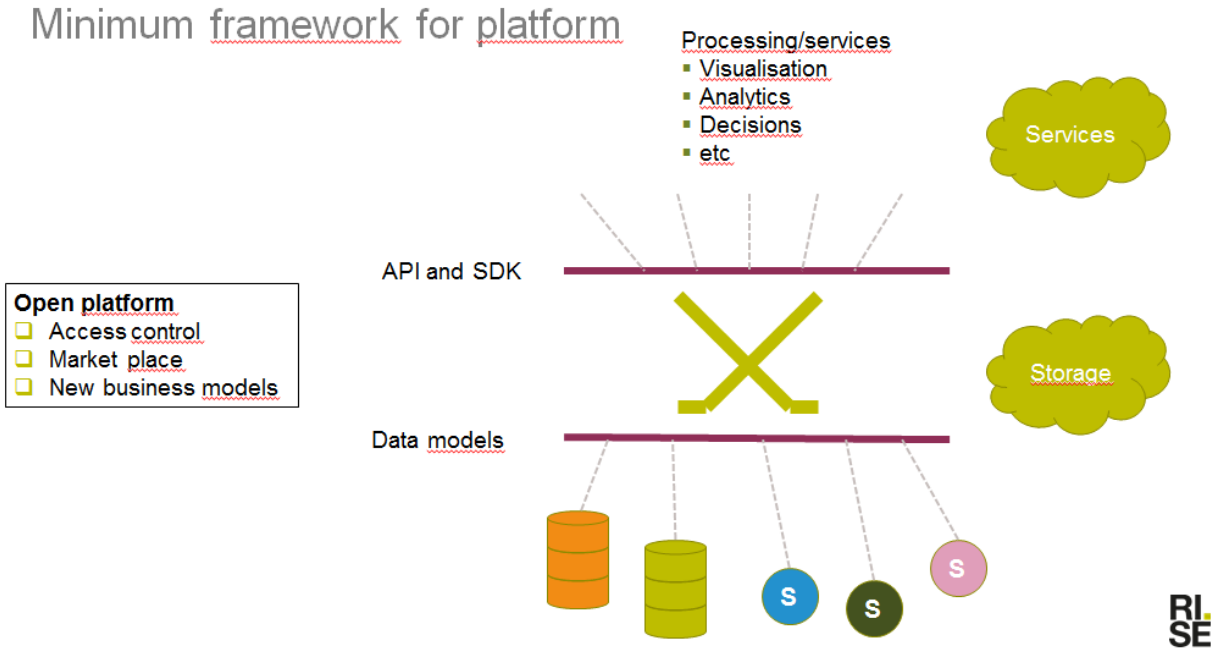
The Software Liaison Group discussed the Top-Down and Bottom-up approach towards micro services.

It is concluded that we should select at least one use case service for which we will develop - in an agile way - a common design across the cities (from core IoT data all the way to end-user service)) to validate and populate our Minimal Viable Architecture (MVA).

Candidate microservices at this moment:

- Predicting energy requirements based on existing building data and models to (1) -Improve building performance and (2) inform citizens
- Combine Traffic Data with Airpollution sensing sensing in a more granular way
- Smartlighting + Airquality Sensors (5K Bosch Multi-sensor)
- Smart Streetlighting + Demand Management (heating domestic)→ Power availability protocol
- EV-Charging ideas are invited, eg universal payment system

NOTES: Blockchain (Payment service?), choose 3 services, one for each city. Next Liaison Group meeting in Umea (March 2018).



Stories on smart city development – EV charging

Both Rotterdam and Umea presented the three main challenges to successfully implement the smart EV charging solutions.

Rotterdam:
Challenges presented by André Houtepen:

- Existing contracts for placing charging units.
- Owners of buildings must agree to put EV panels on their roofs. What's in it for them?
- Design of infrastructures needs knowledge about how much energy will be transported. This is difficult to calculate due to many influences, assumptions and personal opinions.

By ways of a short self-interview on film Virgil Grot (RET – public transport company) gave his perspective on the main challenges. Amongst other things he stresses:

- Two goals: development of planning software to deal with a divers fleet of buses and develop an EV charging hub (infrastructure and battery). PV panels on top of the metro station and perhaps also on top of the buildings in the area should feed into the battery.
- Limited space and lots of stakeholders. How to physically realize and implement the infrastructure?

Umea:
Challenges presented by Jorgen Carlsson:

- Several different payment systems; needs to be simplified for better customer use.
- Technical platform turnover; Technical platforms become outdated in an ever-increasing pace.
- Muddy local implementation strategy; There is a clear national ambition, but there is a huge lag in local roll out.

Frida Sanden (UBAP) and Henrik Bristav (Umea Energi) sent their perspectives on the main challenges. They stress amongst other things:

- EV-charging is a success when we can meet the need for charging by the end-user. When we have created a widespread network of all sorts of EV-chargers, not only in Umeå, but nationally and internationally. When the end user never has to worry about the range of their Electric vehicles.
- Smart solutions is a kind of fuzzy concept but I would say that every time you are able to combine EV charging with something that could bring value to the customer is good. That could be a payment system that seamless combines your charging at home with public charging. That you can charge at any operator without having several subscriptions, and so on.
- The greatest challenge in Umeå is the payment models. Today, we at the parking company charge the end-user by a standard amount added to the parking fee. This because we cannot charge the end user for the amount of electricity that they actually charge their vehicles with since we are not an energy company. Umeå Energi can charge for the energy actually charged. This makes it harder for the end user since they have to pay in different ways at different EV-charging points.
- Another challenge that we face is to predict the development of EV:s for the coming years. Will it boom or will it develop in a slow but steady pace? How fast are we going to expand the public charging? Another uncertainty is which technology that will dominate in the future. Will the demand for high power chargers (HPC, >150 kW) increase rapidly? How can we build with ability to scale up the charging stations?
- To reach the intended success in Umeå we need collaboration and an overall strategy that applies to all partners working with EV-charging in Umeå.
- With a development towards HPC it would be interesting to test HPC combined with battery storage to be able to scale up a station without increase the grid connection which is expensive and seldom used to it full capacity. That gives also an opportunity to install PV to help charging the battery storage. If within RUGGEDIZED could open an opportunity to test this type of installation would be very interesting.

Hardware & Orgware group on EV charging

The discussion on EV charging was meant to explore the different challenges, differences and similarities between the Lighthouses.

Mark Bolech (TNO) presented a short introduction on the topic (please see slides in the Appendix)

Conclusions from the discussion on this topic are:

- Explore a toolkit that really helps the city to get EV-ready, including
  - Practical EV solutions
  - Guidelines and roadmap on how to implement solutions and what choices have to be made
  - What happens if cities go to 100% EV, what kind of transformations paths are there?
- Find ways to deal with parking challenges such as:
  - Who owns the parking lots
  - Who decides on charging rates and amount
  - What to do with different loading mechanisms
- Further explore the relationship between private investments and – innovation on the one hand and public interest on the other.
- Engage with new players such as oil companies, DSOs, automotive OEM. What is their interest and what do they worry about?
- Standardisation: make an overview of what is going on in the national and international standardization bodies, industries and Pseudo-bodies
- Exchange lessons learned on control systems OCPP.

Examples of interesting projects and sides are:

- Grid for Vehicles … the impact of a large scale introduction of EV and PHEV needs to be investigated in detail in order to optimise the infrastructure …

- Green eMotion …The primary goal of the project is to define Europe-wide standards. To this end, practical research is being conducted in different demo regions all over Europe with the aim of developing and demonstrating a commonly accepted and user-friendly framework that combines interoperable and scalable technical solutions with a sustainable business platform. …
- COTEVOS …focus on testing and interoperability: Concepts, capacities and Methods for Testing EV Systems and their Interoperability within the Smart Grids
- ElaadNL is the knowledge and innovation centre (founded by the DSO's) in the field of (smart) charging infrastructure in the Netherlands) Their branch / sister operating physical charge points EVnetNL (in Dutch alas) is busy getting all their infra ready for smart operation.
- NKL is the **N**ational **K**nowledge Centre on **L**aad (Charging) infra structure. In a sense this is the a "toolbox" for making a neighbourhood /city / region EV ready in the Dutch context.
- Quite recent InterFlex investigates the **INTER**actions between **FLEX**ibilities provided by energy market players and the distribution grid, with a particular focus on energy storage, smart charging of **electric vehicles**, demand response, islanding, grid automation and the integration of different energy carriers (gas, heat, electricity).)
- Allego (commercial operation rolling out charging infra from many different manufacturers. Former branch of DSO Alliander)
- Open Charge Alliance everything OCPP
- The New Motion electric charging service provider recently acquired by Royal Dutch Shell

Agenda 2018

During the GA in Umea we will organize a plenary session (to emphasize cross-overs between Hardware, Software, Orgware groups) The themes that will be discussed:

Smart Infrastructure Governance – lead Umea
Building on discussions in previous meetings on how to organise and upscale smart heat energy infrastructure within the cities, especially taking in to account the connection to existing infrastructure interests.

EV charging readiness level – lead Glasgow
Developing a comprehensive guide to successfully implement EV charging infrastructure across the city. What topics should be covered, what decisions should be taken, what partners and interests should be involved and how?

Digital City Platforms – lead Rotterdam
Digital city platforms should provide the basis for developing smart services. How do such services look like and how should data and business model be governed in such a way that it stimulates parties to develop and use the services and feed new data into the platform?

Fellow Cities are welcome to join the meeting to pick up the learnings from the LHC's on the mentioned topics.